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THE NEW, PRACTICAL HOBBY MAGAZINE

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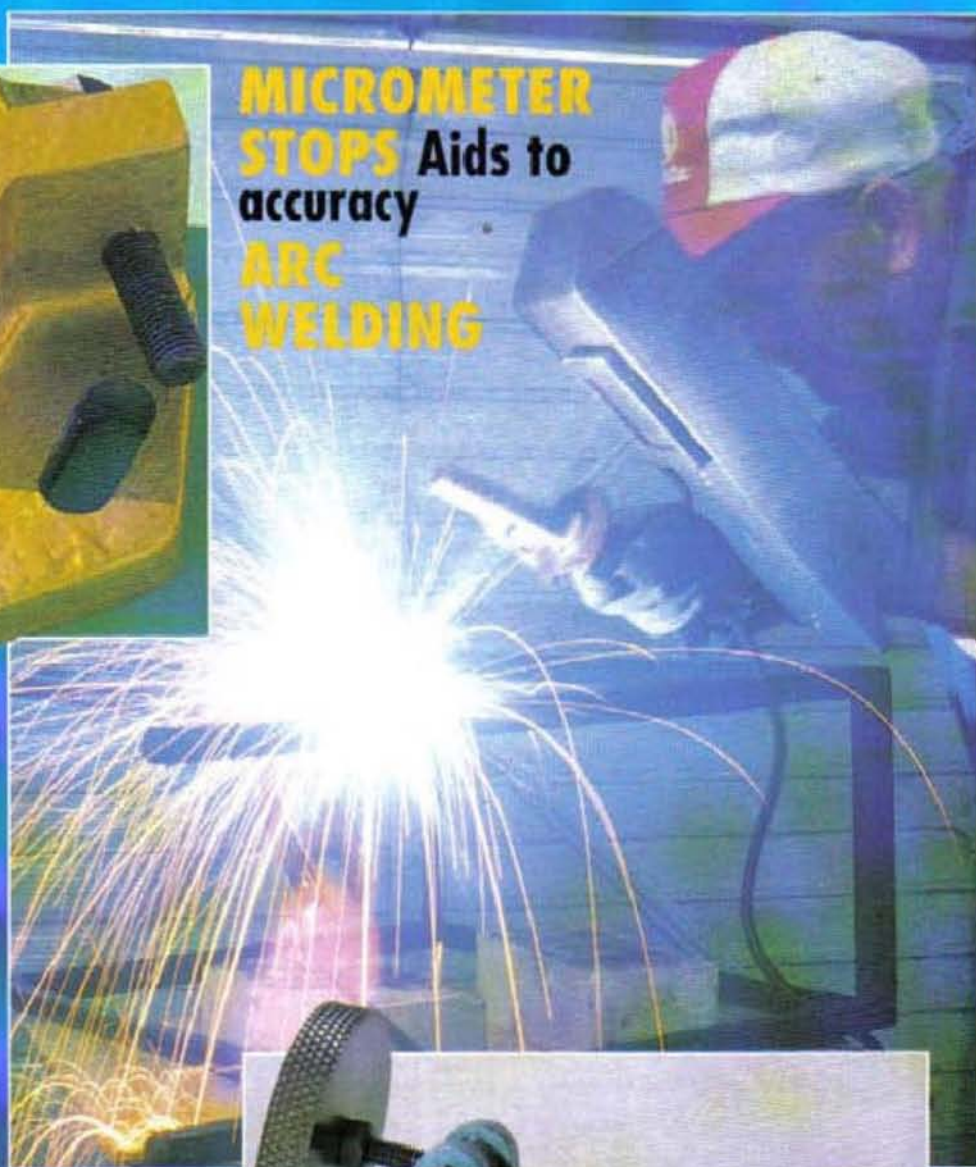


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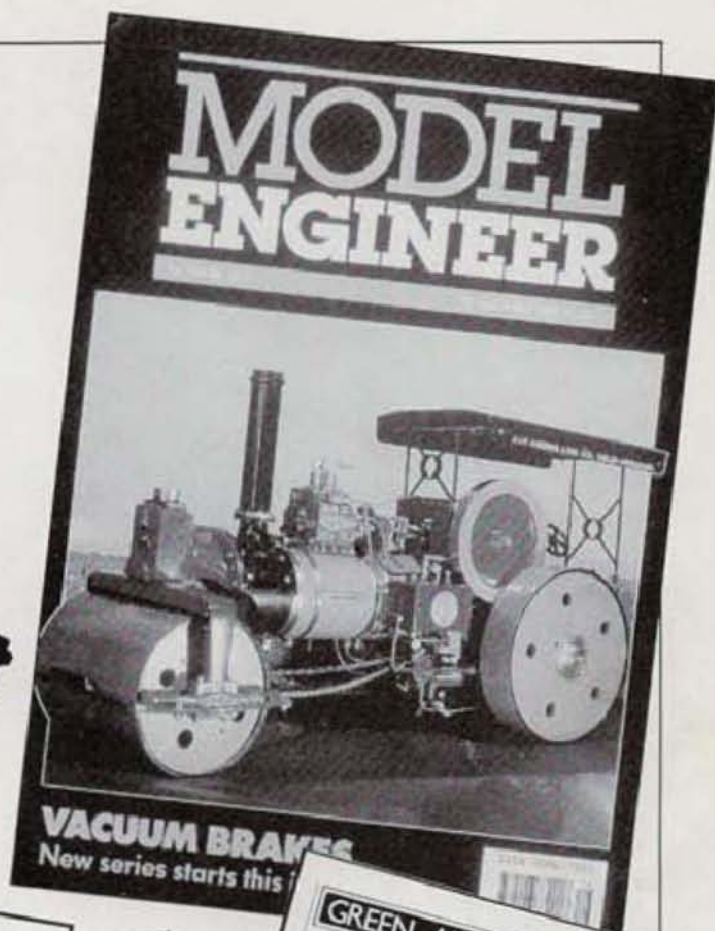
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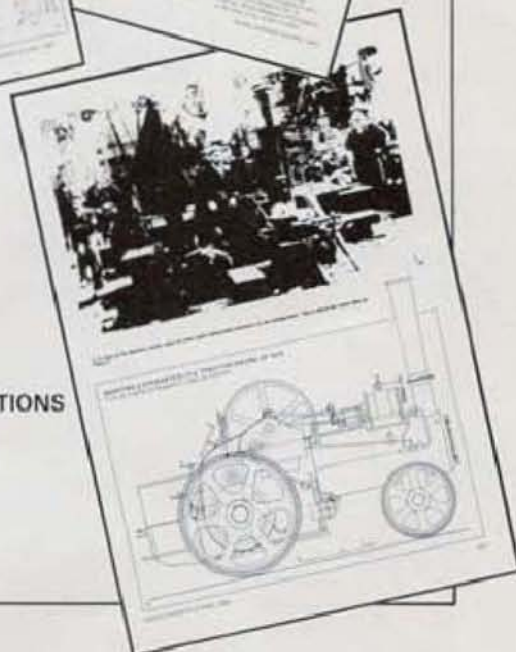
CLUING UP ON CLAMPS
Making and using



**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight



There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).



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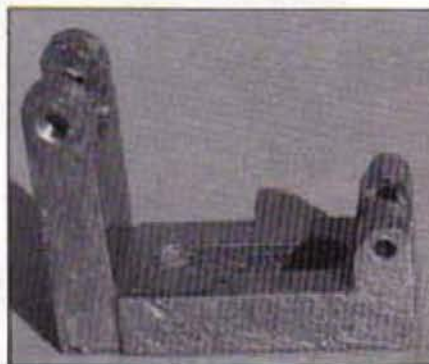
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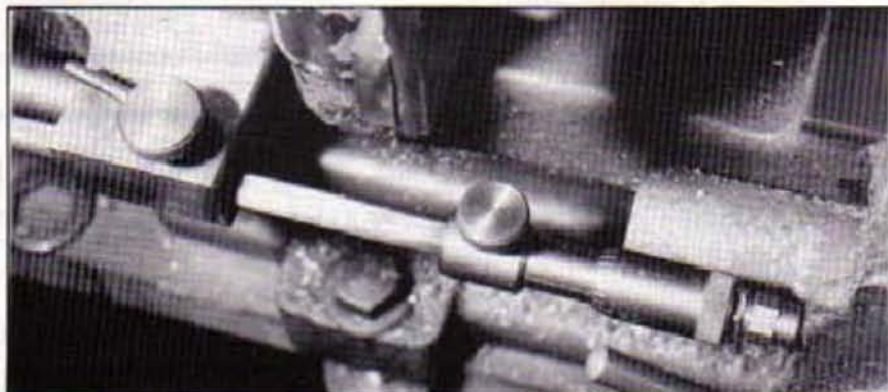
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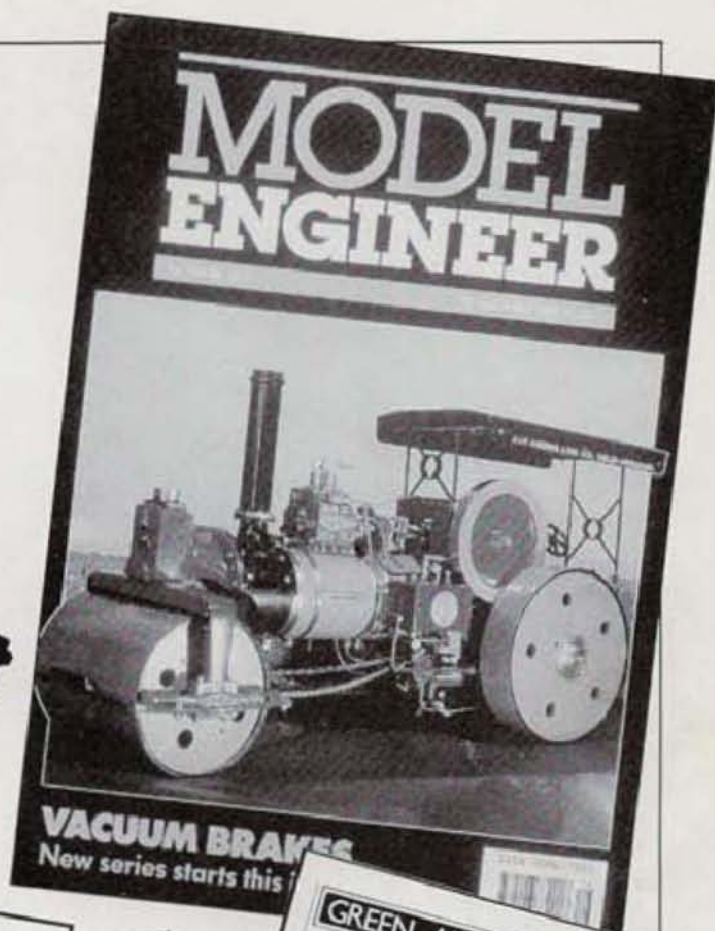
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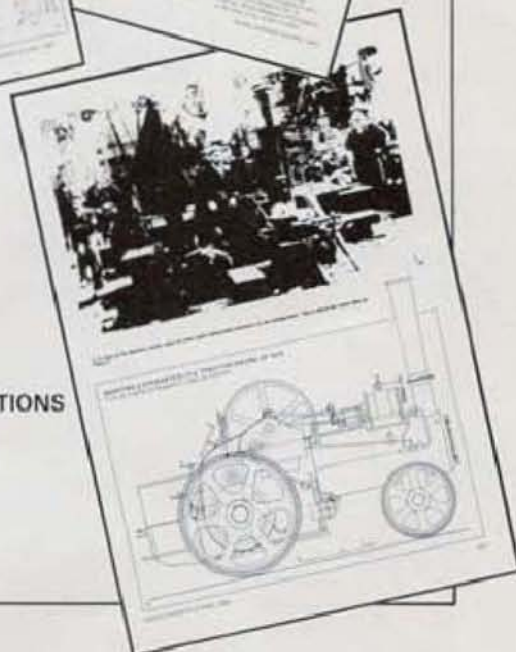
Commercial items of interest



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Stan Bray

ON THE EDITOR'S BENCH

IN OUR NEXT ISSUE!



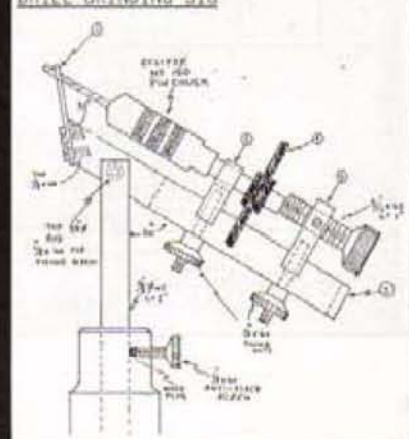
The next issue sees yet another bumper amount of constructional articles! It also will see the first two-part article in the form of a geometric chuck; this does not mean that it is intended to start running interminable series, but is in response to requests from a number of readers who thought that, by finishing each article in one issue we were preventing the publishing of some really high quality material for the advanced worker! With the article on the geometric chuck it became very obvious that some readers would want to make such a lovely piece of equipment, but that it would not go into one issue. It has therefore been split into two sections. It is doubtful if many people are likely to have finished the first part before the second part is published!

We also have a tool post grinder, from Bluey; a neat little tool that will fit most lathes, it does not require castings or large section material. Apart from grinding it can carry out a whole range of useful functions from the tool post, such as drilling, and light milling to name just a couple.

From our old friend Ted McDuffie we have an article on dividing without tears, and showing how to set about the subject at a low cost, and with the use of stock materials.

There will be a machine vice, which again can be made without the use of any castings, and yet is a robust piece of equipment, and also we will have an unusual pair of drill grinding jigs which will cater for grinding drills over an exceptionally wide range of sizes. Once again, these are made from stock materials that are easily obtainable. For the beginner we propose to deal with marking out, and explain how to make simple tools that will help with this function. We will also be showing some more work on the compact type of lathe and a whole host of those little quick tips that make life so easy in the workshop. See you soon!

DRILL GRINDING JIG



As this issue reaches readers, Christmas and New Year will be upon us! I would like to take this opportunity of wishing all our readers a happy Christmas and prosperous New Year. *Model Engineers' Workshop* is not really the sort of magazine in which there can be many articles associated with the festivities, soluble oil on Christmas Pudding rather spoils the taste (of the pudding not the oil!). Nevertheless, a little project for Christmas has been included for those who want something a little different...

So far, the copies of the magazine appear to have been very well received judging by the numerous nice letters that you've written. It is always pleasant to know that one's efforts are rewarded in this way. Many readers have written with suggestions for future articles and these are being looked into. Unfortunately, there was a rather gigantic clanger dropped in the last issue, which is being dealt with elsewhere but apologies are given to all readers; it *should not* have happened!

As 1990 comes towards its close, on December 29th the annual Model Engineer Exhibition starts at Alexandra Palace. Always worth a visit to see how the other fellow does it, this year promises to be something special, particularly as it is the Diamond Jubilee of the event. Inevitably, there are plenty of workshop bargains to be had, and if one visits the club stands, and particularly the Society of Model and Experimental Engineers, then there is always a chance of watching actual workshop practices. Frequently, some of the trade stands also show how it's done as well. Who knows, perhaps I will get a chance to meet some of our readers there and hear in person what they think of, and want from, the magazine.

Model Engineers' Workshop has proved a runaway success since it was started. It is hoped it is mainly because the standard set has been high and it is proposed that that standard will continue. We are pleased to

say, however, that in response to a big demand it will be produced bi-monthly after the first complete year of publication. This means that the next issue will appear at its normal time in March, the following one will be two months afterwards, and from then on every two months. For those ordering it on subscription it will mean a revised payment for the next twelve months and the new rates are printed on the contents page.

We can still do with articles from readers. Let us know what it is you are making and pass your ideas on to others who have the same interest. It is a very satisfying thing to do, I can assure you. If the article can be typed, then please do so in double spacing with a one inch or so margin each side. If you cannot type, then we will sort that out for you. Drawings can be pencil sketches for those of you who cannot do otherwise, and photographs can be either colour or black and white prints. There we are - it is not all that difficult, so why not have a go? In the meantime, my thanks to those who have sent articles to us, and particularly to those readers who have sent us their favourite quick tip.

In this issue we have, once again, managed a range of projects to suit all abilities. There are simple turning exercises up to high precision work. If you do not think you can cope with some of the more advanced projects, then I would suggest you read them anyway. Most of the articles contain bits and pieces relating to normal workshop practice and some of the more advanced authors are passing on knowledge gained over many years of experience. The running centre, for example, explains a great deal about screw cutting, and the micrometer stops much about graduating. All very useful advice.

Well, there we are. Progress continues to be made with the magazine, and all that remains is for me to once again wish everyone the compliments of the season.

A GEARBOX FOR THE ML7

This article by Alan Buttolph is for the more experienced machinist. Nevertheless much of the information contained in it can also be absorbed by those with less experience who do not wish to make the excellent gearbox described. In order to make a compact unit the author made his own gears. He does not give details on the exact methods but refers readers to the Argus Workshop Practice Series Book number seventeen by Ivan Law on *Gears and Gear Cutting* which explains the methods that can be used in simple terms. It's an excellent book which we would recommend to anyone interested in gears...



Photo 1. The completed gearbox takes up very little extra room on the lathe.

The advantages and desirability of a self-contained gearbox become very obvious when one has to fit screw-cutting sessions in between plain turning operations. After some years of patiently setting up the tumbler gears, resetting them and resetting them yet again, all in the process of producing one small component, I began to feel that the time and effort saved by installing a gearbox might well repay whatever energy I might have to divert towards that end. Having a working experience of the Norton type of gearbox I wondered if it could be the basis of a design within the constructional capabilities of the owner of a Myford ML7 lathe.

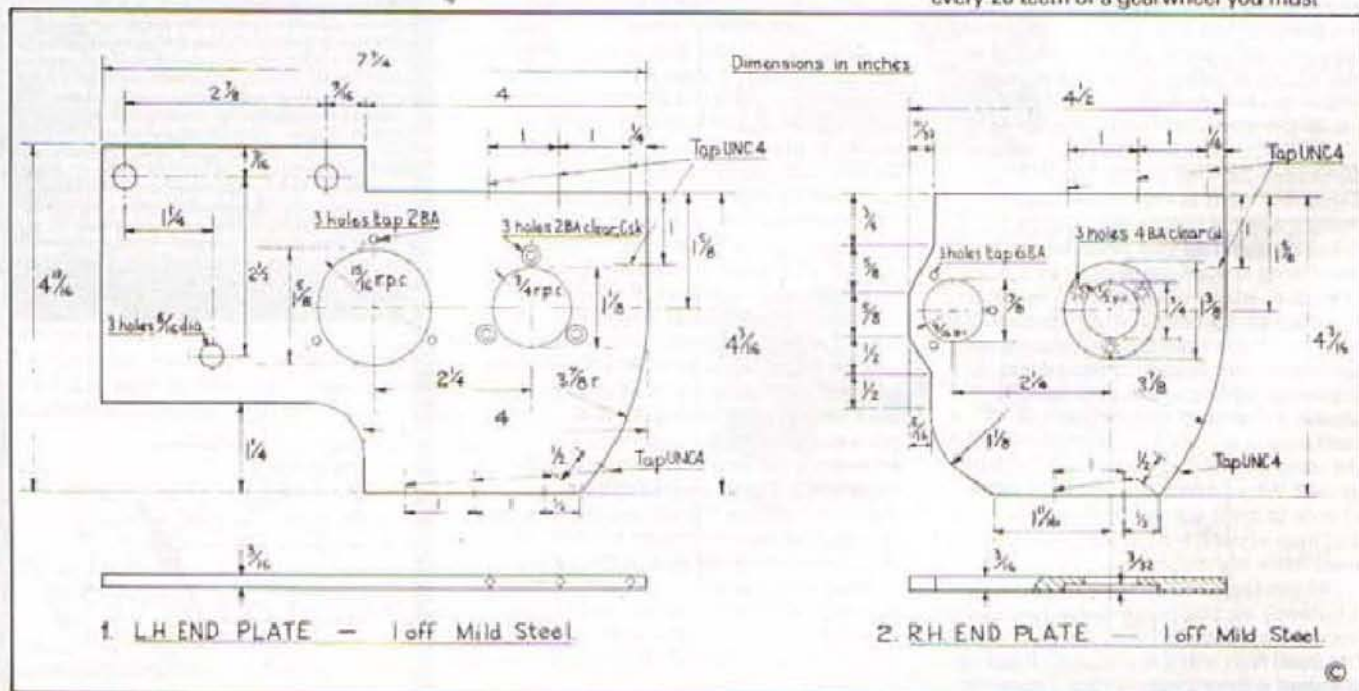
Once I began to look into the serious possibilities I found that, not surprisingly, a suitable design had already been worked out and that drawings were available from the respected publishing house of ASP. This was encouraging and I took the obvious step of getting hold of such details as are published.

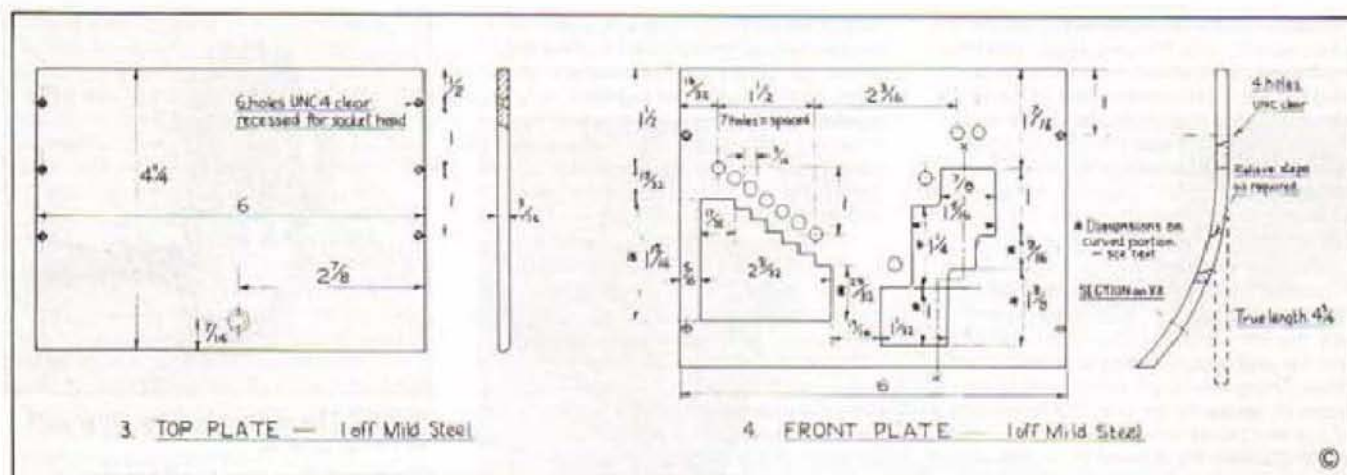
A detailed study of the drawings revealed two things. One, that the design was sound and provided just what was required. Two, that it would take up too much room in proportion to the size of my ML7 and in the confines of my somewhat restricted workshop space. I wanted something more of the size that Myford fit to their more expensive models and amenable to production on an ML7. Many sketches and several design possibilities later I felt convinced that the ASP design by Mr L. H. Sparey was as good a proposition to start with as might be produced by a determined model engineer.

The design

So, concentrating on the basic design, I set out to fit the works into the space restrictions I had set. To jump well ahead of detailed descriptions, I have managed to produce a good, sound gearbox with overall dimensions of $6 \times 4\frac{1}{2} \times 4\frac{1}{2}$ ins., excluding gearchange levers. The photograph shows how well it blends in with the general proportions of the lathe. (Photo 1).

The published ASP design uses gears of 20 Diametral Pitch, or 20 DP. That is, for every 20 teeth of a gearwheel you must





allow 1 in. in the diameter of its pitch circle and pro rata. So a wheel of 80 teeth would have a 4 in. dia. pitch circle; one of 45 teeth a 2 1/4 in. dia. pitch circle and so on. Clearly, wheels of 20 DP are larger than those of 30 DP but are smaller than 16 DP wheels. Cast-iron wheels of 20 DP are quite strong and will stand up to all the shocks and stresses that the amateur's lathe is heir to and, for this reason, are standard on the ML7. However, for a self-contained gearbox there is no essential need to adhere to the same standard of 20 DP. By using a smaller size of teeth I could employ smaller diameter gearwheels and hence reduce the space needed overall.

I ended up by revamping the published "Sparey" box by using gears of 28 DP and making them of steel and $\frac{1}{2}$ in. wide. Such gears will present no difficulty in dealing with the sort of use to which the ML7 is subjected.

The box frame in which the gears, shafts, bearings and levers are accommodated is also an exacting matter and must meet four essential requirements. It must conform to the existing design of the lathe regarding the position of the leadscrew and tumbler-gear provision and not interfere in any way with the normal operation of the lathe. It must be capable of being attached to the lathe securely and accurately, with minimum attack on the existing fabric of the lathe. It must be self-rigid to maintain proper alignment of shafts and gears under working conditions. And it must be capable of construction from materials reasonably available to the amateur constructor without the need for special castings or forgings. In fact, such a 'fabricated' gearbox has distinct advantages over one based on special castings.

hand end of the lathe bed which secure the plate which holds the gear cover; and two additional holes which have to be drilled and tapped in the vertical face of the bed a short distance in from the left-hand end. These latter holes take the screws which hold the central bearing pillar of the box firmly to the bed and, together with the end securing screws, hold the complete box rigidly and accurately in position.

You will see from the drawings that the framework of the gearbox consists of five items made from $\frac{1}{2}$ in. steel plate. These are, the left-hand end, the right-hand end, the top and bottom plates and the front plate. There is no back plate; there is no room or necessity for one. The front edges of the end plates are curved to accommodate the shaped front plate which is curved to allow the travel of the gear-change levers up and down its face. The back edges of the right-hand end plate and the bottom plate are shaped to fit the lathe bed contours and this is necessary also for the central bearing pillar where it is secured to the lathe bed.

Start with the framework of the box. Some milling is needed and a milling machine or similar is a great help. But what is needed can be accomplished in the lathe with the usual set-up for milling. First

cannot be very large. For $\frac{3}{8}$ in. plate, NC 4 socket-head screws about $\frac{1}{2}$ in. long are about right. Mark out the positions of the holes on the face of the top plate very carefully. Centres must be just half the thickness of the plate in from the edge. Drill clearance holes in these positions, 2.9 mm for NC 4 screws. Don't worry about counterdrilling for the heads yet.

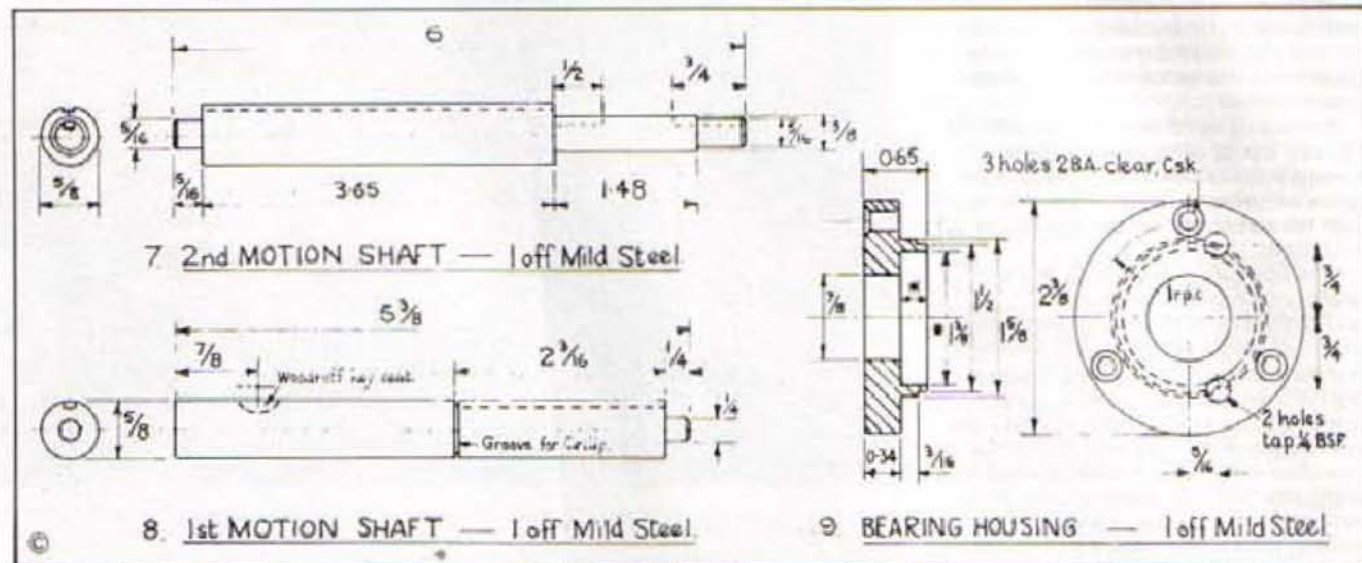
Clamp the top and bottom plates together so that ends and bottom edges register. Just a word of warning here: Take care not to get any plate upside-down. It is easily done, so check at each operation. Using the holes in the top plate as a guide, drill through the bottom plate also; that is, five clearance holes 2.9 mm dia. Separate the two, take the top plate and set it against the *edge* of the left-hand end plate with which it will mate. Position it as firmly and accurately as you can and then drill through the top plate holes with the clearance drill for about $\frac{1}{4}$ in. into the edge of the end plate for all three holes. Remove the top plate and with the correct tapping drill – 2.3 mm for NC 4 – continue these holes to a depth of about $\frac{1}{4}$ in. Drill carefully, clearing swarf frequently. There are not many such holes and a broken drill causes grief out of all proportion to the crime of undue haste. Controlled plodding is much quicker in the



Photo 2. The central bearing pillar with its fixing screws.

Dismantling the leadscrew

Now comes the stage at which you can proceed to dismantle your existing leadscrew. This is not an irreversible step; the rugged design of the Myford ML7 is such that reassembly automatically ensures accurate location of the parts involved. First remove the gearwheel and collars from the end of the leadscrew, take out the Woodruff key and take down the tumbler-gear quadrant assembly and set it all aside. Remove the change-over gear cluster from



machine the two plates to size, leaving the curves on the front edges until later. Leave a few hundredths of an inch on at first, then drill locating holes in each plate, say 0 BA, at the centres where the shafts will finally come through, tapped in one plate, clearance in the other.

Secure the two plates together with 0 BA screws and then finish off as one, on the top and bottom edges and the curved front edge. Now machine the top plate to size making sure that sides and edges are square. Machine the bottom plate to the same length as the top plate; machine its front edge, leaving it unbevelled for now, and shape the back edge to within filing distance of its final shape as shown in the drawing. If your lathe is the same model as mine, the contours will not be very different, but you can check fairly closely by cutting thick card to the dimensions given and trying it against the bed for size and shape.

The top and bottom plates are secured to the end plates by socket-head cap screws that fit tapped holes in the thickness of the end plates. You will appreciate that these holes, and therefore the screws,

long run! (*Ecclesiastes 9,11*)

Now repeat this with the top plate positioned firmly on the top edge of the right-hand plate, then proceed to tap the six holes in the top edges of the end plates. As just advised, take it *very* steadily, withdrawing the tap frequently to clear the swarf. Do not clamp anything in a vice but do a hand held job for all such holes, the number of which is kept to a minimum.

After checking that screws and plates assemble correctly, you can counterdrill the top plate to sink the cap heads flush – 4.5 mm drill for NC 4 heads. Do not, at this stage, fit the bottom plate to the end plates.

Central bearing pillar

The next item to tackle is the central bearing pillar which will house the ball-bearings for the leadscrew on the right and the input driveshaft from the left, on a common centreline. Machine the $\frac{3}{8} \times 1\frac{1}{2}$ in. bar to the correct length of 4½ in. to match the depth of the end plates. Ensure that its ends are square to the length, machine the back face which will fit against the lathe bed, to the dimensions as per the drawings, then drill the two $\frac{1}{2}$ in. dia. fixing holes through from the front face. (Photo 2)

the top stud and then take off the flat cover plate which supports the gear cover. At the right-hand end of the lathe remove the socket-head cap screws that hold the leadscrew end bearing. Then the leadscrew can be carefully withdrawn through the left-hand end bearing and the open claspnut of the apron and put in a place of safety.

The vertical face of the bed is now accessible for the shaping of the right-hand end plate and the central bearing pillar. You should find that shaping these to the given dimensions will bring them close to the final fit to the face of the bed. With trials and filing you can achieve the correct fit to your particular lathe bed profile. The side of the central pillar should be vertical when finally fitted and its correct position is such that its top end is flush with the underside of the top plate. So we now proceed to get the top plate into correct position so that we can see where to drill the holes to hold the pillar to the bed.

Remove the remaining leadscrew bearing, then fit the lefthand end plate of the box to the end of the lathe bed, using the three $\frac{1}{2}$ in. BSF locating screws. As the

The pillar can now be assembled in position by the screw through the top plate, checking that its sides are square to the top

The bottom plate can now be tried for correct location, its back edge being filed

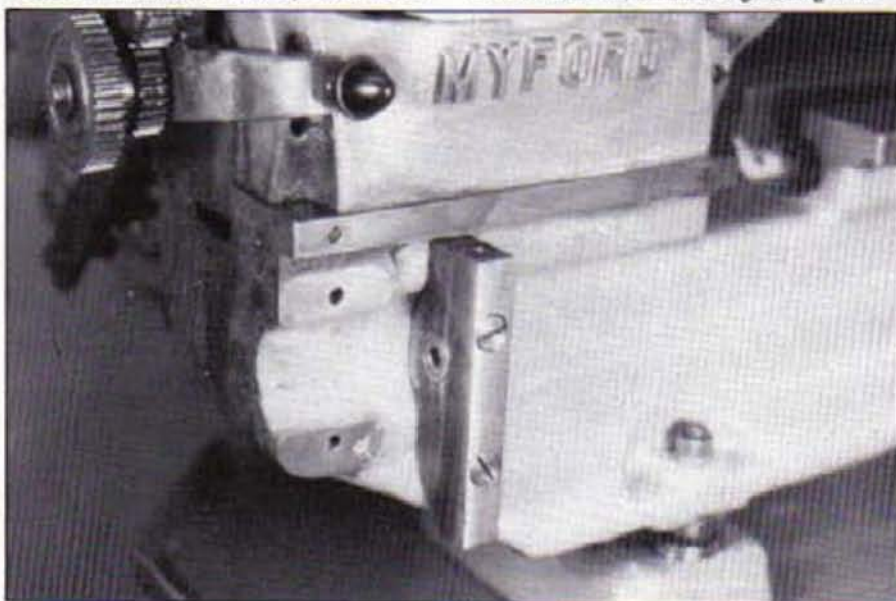
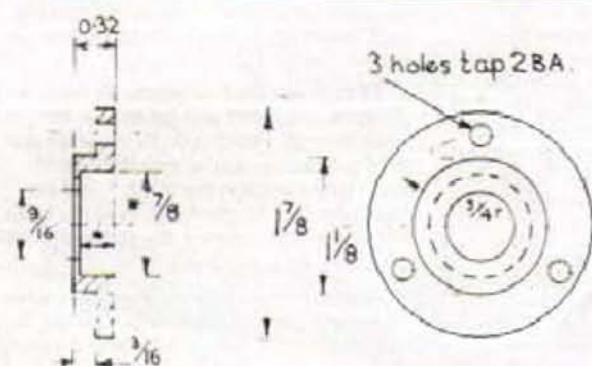
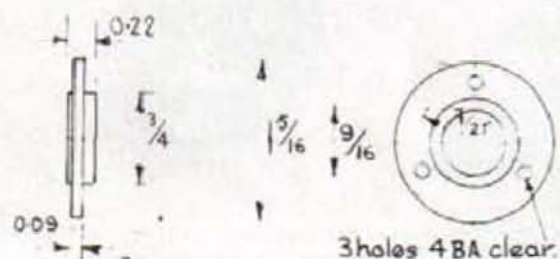


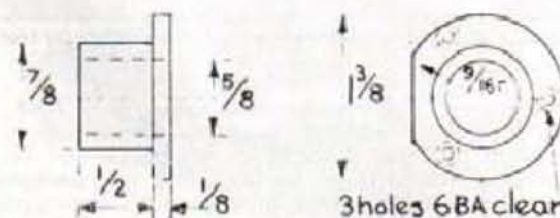
Photo 3. The central bearing pillar in position; it can be fixed securely after checking for fit.



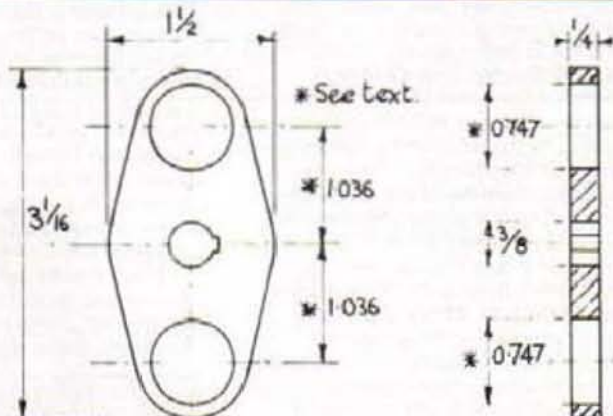
10. BEARING HOUSING — 1 off Mild Steel



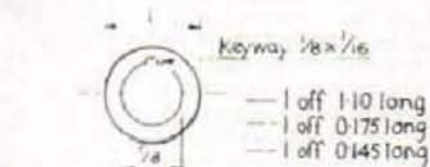
11. BEARING SUPPORT — 1 off Mild Steel



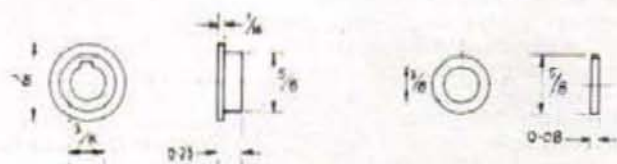
12. BEARING BUSH — 1 off Bronze or Brass.



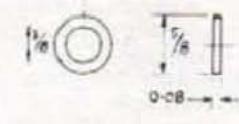
13. CARRIER ARM — 1 off Mild Steel.



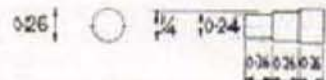
14 SPACING COLLAR—Mild Steel



15. COLLAR — 1 off Mild Steel



16. COLLAR. 1 off M.S.

17. SHAFT for PLANET GEARS 2off MS

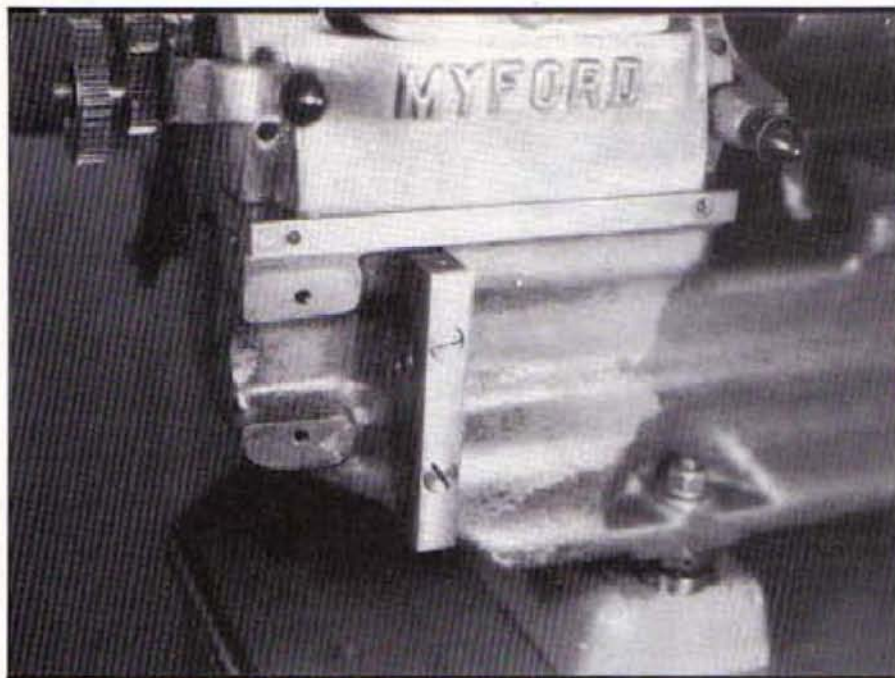


Photo 4. Another view of the central bearing pillar in place on the face of the bed.

and bevelled to achieve reasonable fit to the bed. Bevel the front edge also to match the curve of the end plates. Mark its proper location on the end plates, remove the whole frame and drill and tap the fixing holes in the bottom edges of the two end plates. With the four plates firmly assembled, fix the central pillar by its screw through the top plate. Mark the position of the hole to fix the pillar to the bottom plate and drill and tap this hole.

Assemble the pillar in the frame again and you can try the whole assembly back on the lathe and check for fit. If all seems well, remove it, take out the central pillar and fix just this item firmly in its position the face of the bed. (Photo 3 and 4)

We now require to determine the position of the bearings to be carried by the pillar; that is, where the existing leadscrew centreline will run through the pillar. A simple dodge will pick up the centreline accurately. Refix the left-hand leadscrew bearing back into position this has a good long bush, $\frac{1}{2}$ in. bore. Take a short length of $\frac{1}{2}$ in. dia. silver steel, long enough to lie in the bush and reach to the face of the central pillar. If necessary, ease it down to a sliding fit in the bush. Reduce one end to about $\frac{1}{4}$ in. dia. and on this, form a 'centre-punch' point concentrically and harden it. With this in the bush, a tap with a hammer will locate accurately the position to bore for the bearings.

The pillar can now be set up on the face-plate centred, punchmarked, and bored to take the two bearings with a good press fit. The space available restricts the size of these bearings to $\frac{1}{2}$ in. dia. or not much more. For the same reason, a plain bush carries the leadscrew through the right-hand end plate.

We can now deal with the housings which carry the bearings in the end plates. The holes in the plates are on two common centrelines, so clamp the plates together, aligning corresponding edges, and drill undersized holes which can be bored out individually to take the housing. Turn up the housings, assuring a good press fit for the ball race outer rings. Turn the bronze journal bearing to the dimensions given, brass being a reasonable alternative here. (Photo 5)

Shafts

It is helpful at this stage to produce two short shafts from $\frac{1}{2}$ in. dia. bright mild steel. One of these is the actual input or first-motion shaft and the other is a temporary or dummy shaft to simulate the gearbox end of the leadscrew. Insert these in the frame for a trial fit. This will help in the final location of your housing which can then locate their fixing holes tapped into the end plates. Make these shafts a fairly free fit in the relevant bearings as you will have them in and out several times, and do not yet fit a circlip to the first-motion shaft.

Make the second-motion shaft next. The dimensions on this are important as there must be no axial movement of the gears mounted on this shaft. When you have

start on fitting the gears to it.

The gears

Details of all the gears required are given in the Table. All are of mild steel and the cluster of seven together with the 80-tooth and the two 40-tooth wheels must be bored for a good fit to the $\frac{1}{2}$ in. dia. of the second-motion shaft. Each of these, except one of the 40-tooth wheels, has a key-way to drive or be driven from the keyed shaft. The shaft itself requires one long key and two short keys, all $\frac{1}{2}$ in. square section steel.

The epicyclic gear train is a nice, compact way of getting a speed reduction of about 7 to 1 – actually 6.9 to 1. The carrier arm needs care to ensure that holes are truly perpendicular to the face. The holes for the bearings for the planet wheels must be located as accurately as possible, any slight error in distance from the shaft axis being on the plus side. These holes must accept the small, ball-bearings with a good, true press fit. The short shaft in each of these bearings carries an 18-tooth and a 20-tooth gear, both immovably fixed to the shaft. The larger end of the shaft carries the 18-tooth gear in which it is a force-fit and pinned. Assemble the 18-tooth gears on their shafts and press the shafts into the bearings already in the carrier arm. The 20-tooth gears are bored to a force-fit on to the shaft protruding through the bearing – BUT, assemble only one 20-tooth gear as yet!

First, finish the two gears, 40-tooth and 20-tooth, mounted and pinned on the brass bush Item 28. Slip this on to the shaft and then the carrier arm so that the two 18-tooth gears engage the 40-tooth wheel. Now offer the 38-tooth wheel to the shaft where it should engage the one assembled 20-tooth planetary wheel.

Take the other 20-tooth planetary wheel and hold it against the end of its shaft. Turn it to a position where it will mesh properly

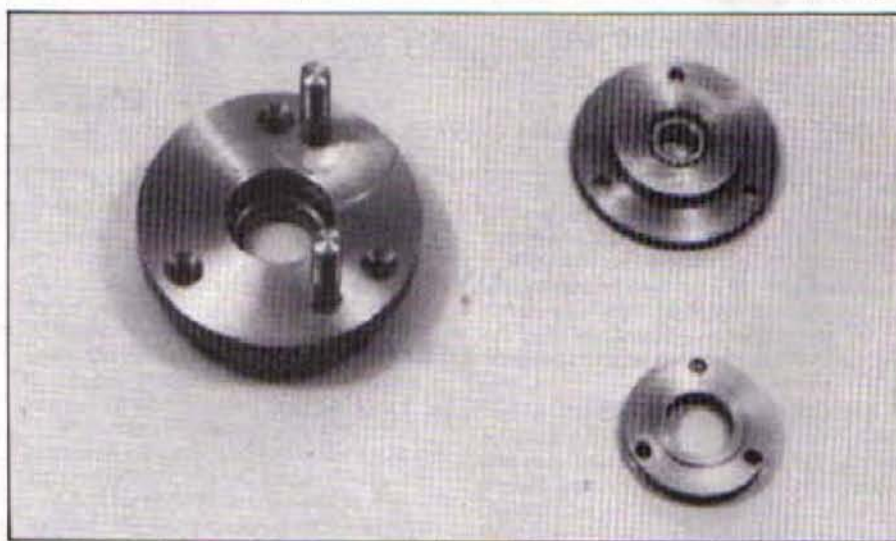
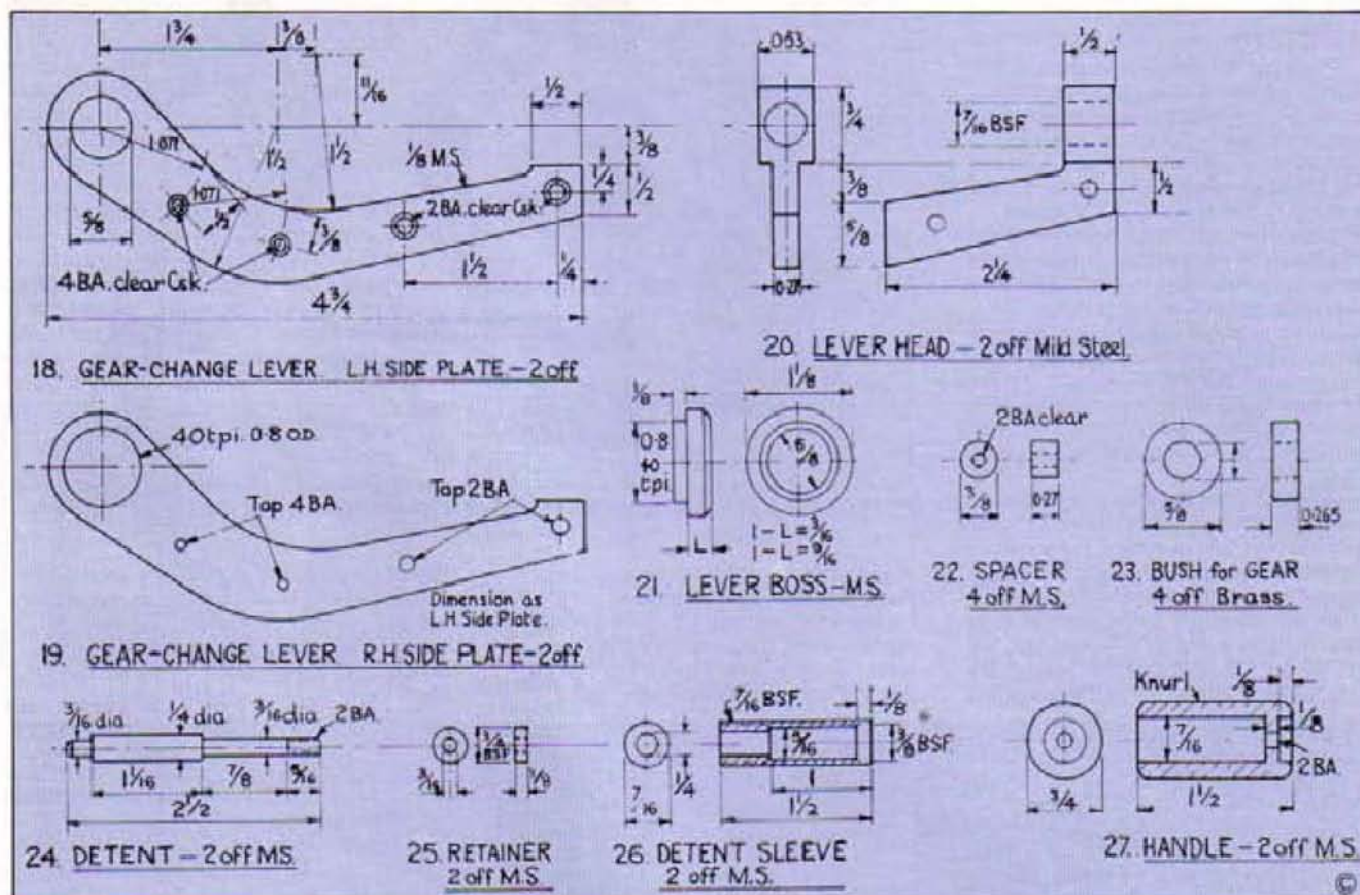


Photo 5. The three bearing housings; the largest carries the two fixing studs for the existing gear quadrant.

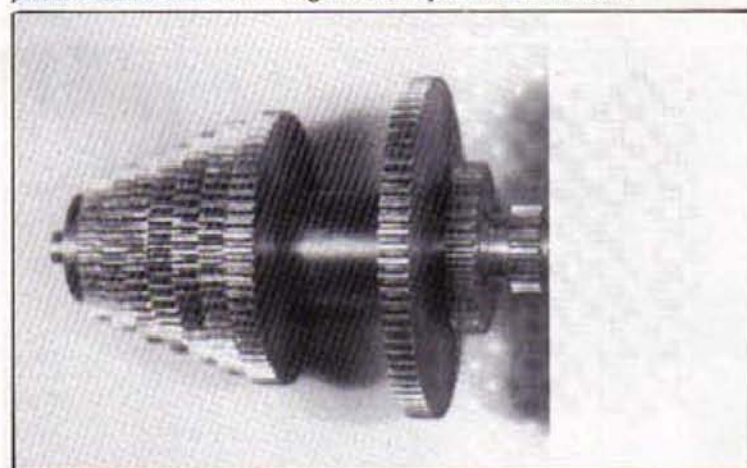
finish-turned it you can reassemble the gearbox framework, this time with the second-motion shaft in position and also fit the other shafts. With all screws nice and tight, the shafts should rotate freely without shake or endplay on the second-motion shaft. You will appreciate the desirability of a push but not-to-tight fit on the bearing ends of the shafts as we must now remove the second-motion shaft again to make a

with the 38-tooth wheel and gently tap it into position for a short distance on its shaft so that it stays there while you remove the assembly from the shaft again. Without disturbing it from its position, you can now press it all the way on and pin it in position. (Photos 6, 7 and 8).

The gear-change levers are built up from $\frac{1}{2}$ in. mild steel plate and are very strong and rigid in operation. When making



Above, photo 6. The output end of the second-motion shaft. Below, photo 7. Same shaft with all gears and spacers assembled.



the side arms - screw them together in mating pairs before finally finishing to size and boring the ends to an easy sliding fit on the shafts. After separating, set up the right-hand arm of each pair on the face plate, open out concentrically to 0.768 in. and cut the internal 40 tpi. This will mean restoring the dismantled leadscrew and tumble-gear quadrant, of course.

Turn up the two bosses, Item 21, cutting the 40 tpi to fit firmly in the arms and bored to slide easily on the shafts. The handle for each lever with its springloaded detent is fairly straightforward and can be oil-blackened. The compression spring for each handle is of 22 or 24 gauge spring wire, free length 1 1/2 in., 1/8 in. OD. (Photo 9)

The 30-tooth sliding gears, after being bored to slide easily on the shafts, are fitted each with a key hard-soldered in place and cleaned up to an easy fit on the keywayed shaft.



Photo 8: Another view of the second motion shaft complete with all spacers and gears.

The front plate is quite a problem. To shape a $\frac{1}{2}$ in. thick steel plate to a fairly accurate curve needs resources not normally found in the amateur workshop. With plenty of heat, a good rugged vice and a heavy hammer, one can get the plate to conform fairly closely to a simple template, hammer marks being of minor importance. If this seems formidable there are two possible options. First, use thinner steel plate, say $\frac{1}{4}$ in., which is more amenable to bending in the vice. Second, use aluminium alloy which is much easier to bend with only moderate heat. The only drawback to the latter is possible wear on the face by contact with the detents over a period of time, but you may be prepared to accept this.

I found it advantageous to make up a trial plate from easily worked thin aluminium to help in cutting the somewhat complex openings for the gearchange levers. Fit this to the front by the screws which will eventually hold the actual front plate. Remove it and by drill, hacksaw, file etc., cut out the slots to within reasonable filing distance but do not at this stage drill

the locating holes for the lever detents. Assemble the gearchange lever on the first-motion shaft and you can, with a little manipulation, pass the front plate over the lever handle and fix it to the front of the box. Do not assemble the other lever.

Remove the top plate of the box and you can see clearly how the gears on the lever will engage the seven wheels on the second-motion shaft, but we first concentrate our attention on the end wheel. Mark the front plate where it appears to

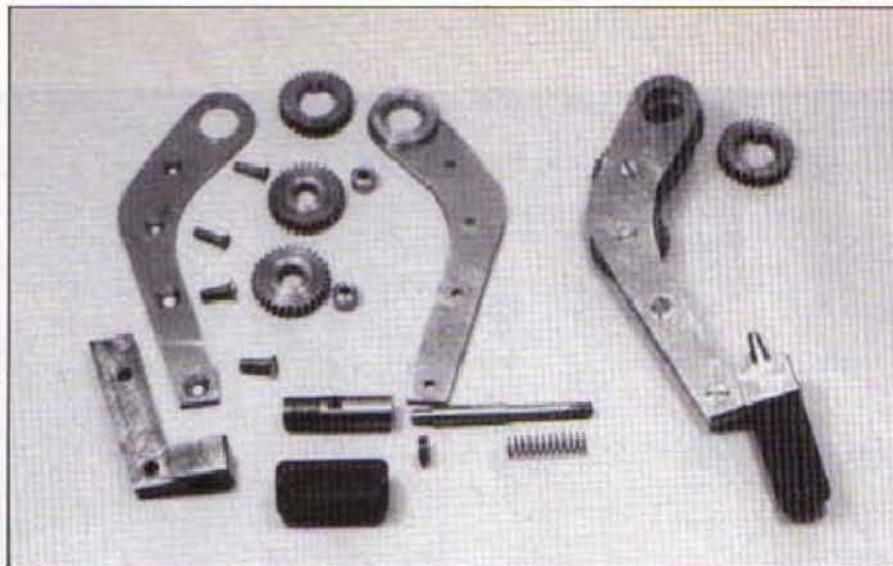
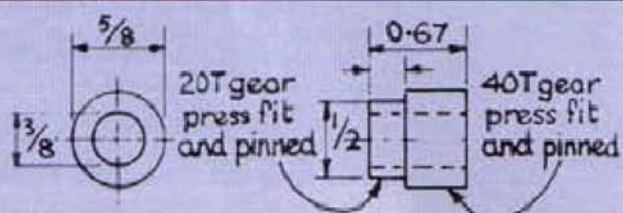
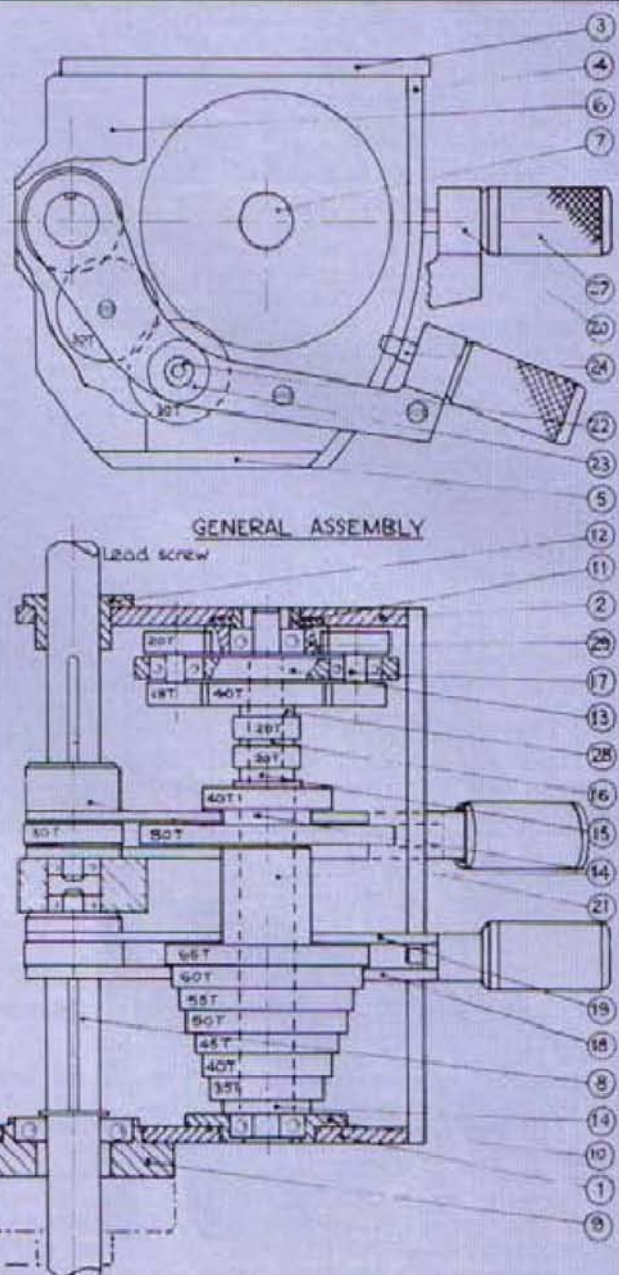
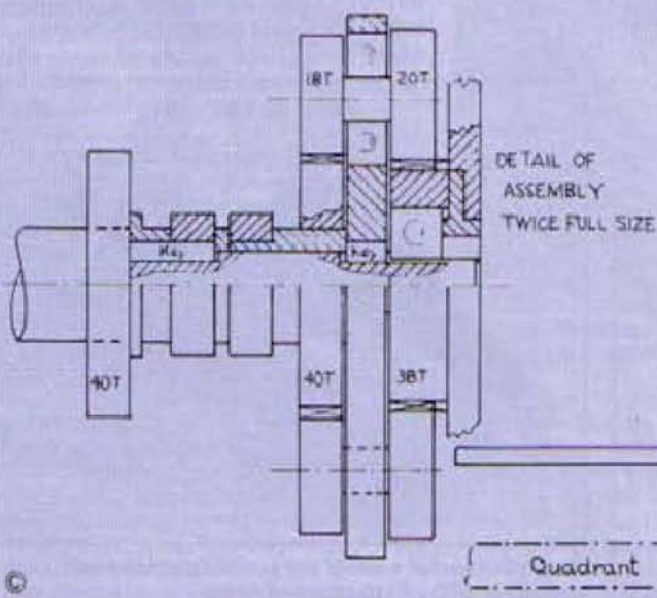


Photo 9. The various components of the gear-change levers and their final assembly.



Technical drawing of a shaft and pulley assembly. The shaft is a vertical cylinder with a diameter of $\frac{1}{2}$ inch and a length of $\frac{5}{16}$ inch. It has three holes, each with a diameter of $\frac{1}{4}$ inch and a depth of $\frac{3}{4}$ inch. The pulley is a horizontal cylinder with a diameter of $\frac{1}{2}$ inch and a length of $\frac{5}{16}$ inch. It has three holes, each with a diameter of $\frac{1}{4}$ inch and a depth of $\frac{3}{4}$ inch. The shaft is inserted into the pulley, and the text "Press fit for B.B." is written next to the shaft. The text "3 holes tap 4BA" is written below the shaft.

29. Detail of 38T Gear



need adjustment to allow correct meshing of the gears in the end position. Remove the front plate, file to the new requirements, replace it and try again. Repeat until the locating slot is right. Do this for each of the other six positions of the lever. You get very good with practice! (Photo 10)

With plate in position, check that the detent locates the position of the holes when correctly meshed with each gear. It is useful to replace the handle and detent with a pointed short length of $\frac{1}{4}$ in. diameter silver steel which could then mark the position of each hole correctly. Drill the locating holes, assemble the other gear-

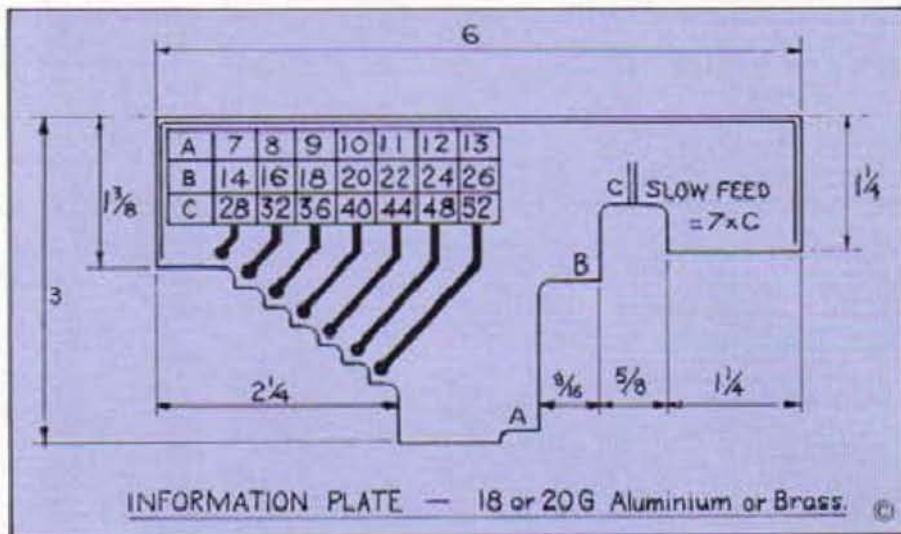


Photo 10. The partly curved front plate has rather complicated openings cut for the gear-change levers.

change lever and repeat the process for correct meshing positions on the right-hand side of the shaft. This also shows the advantage of not having to deal with an enclosed casting for the frame!

Testing

You now have a workable, if temporary, front plate and you can if you wish give your assembled gearbox a tryout. Set it up



on the top-slide, first removing the lathe cross-slide, with the protruding shafts between centres and a driving carrier on the first-motion shaft. See that the assembly is firmly secured to the table at correct height and that turning over by hand does not produce dire results or horrible noises. Run on the slowest lathe speed – not back-gear – and try the change-lever positions. Oil and grease are clearly beneficial and once you are satisfied with the results after necessary adjustments you can 'run in' the gears for as long as you like. When you are satisfied, remove the temporary front plate and use it as an accurate template to make the permanent front plate from whatever

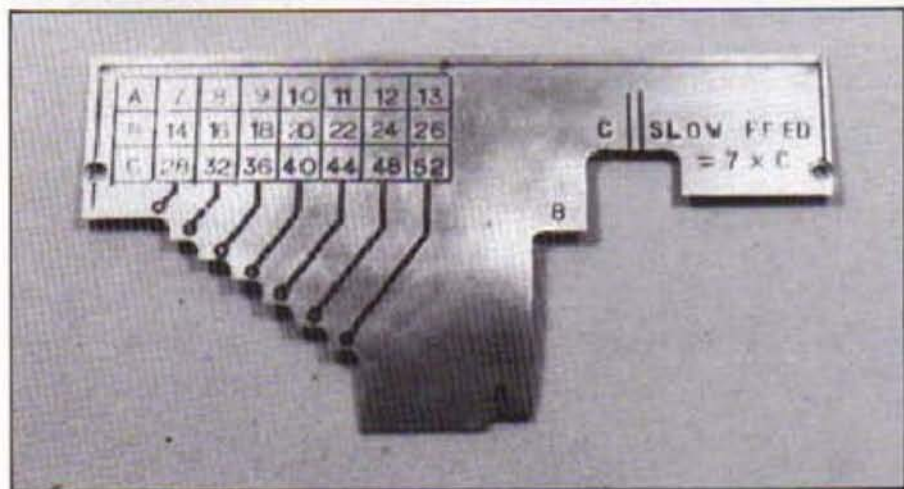
material you have chosen.

Having got this far successfully you will, no doubt, be in the frame of mind to proceed with the irreversible surgery to your leadscrew. This could well produce mutinous feelings in any lathe-respecting amateur but resolve will be strengthened by the thoughts of all the savings in time and trouble by the use of the gearbox.

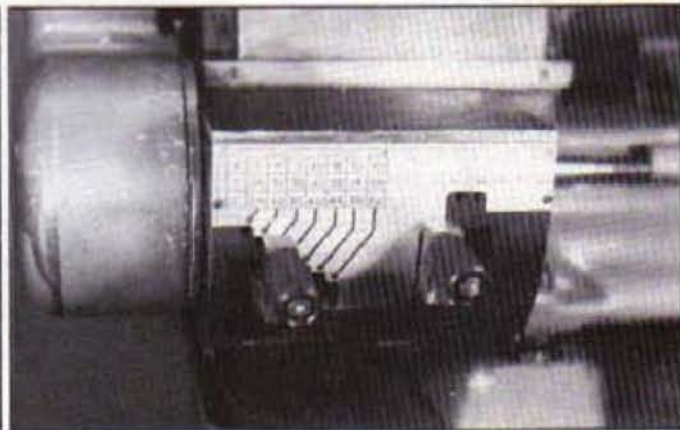
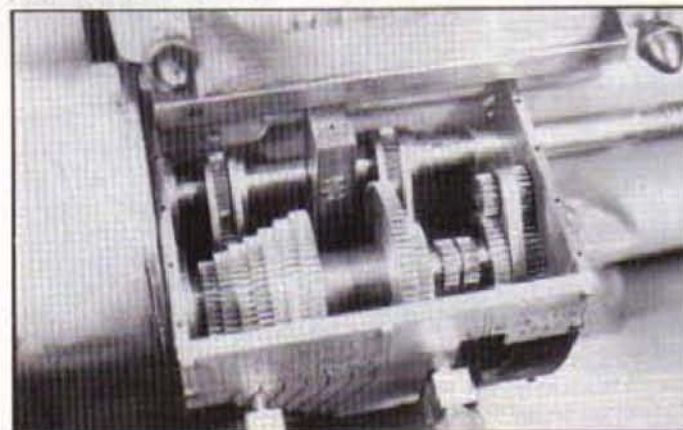
Adapting the leadscrew

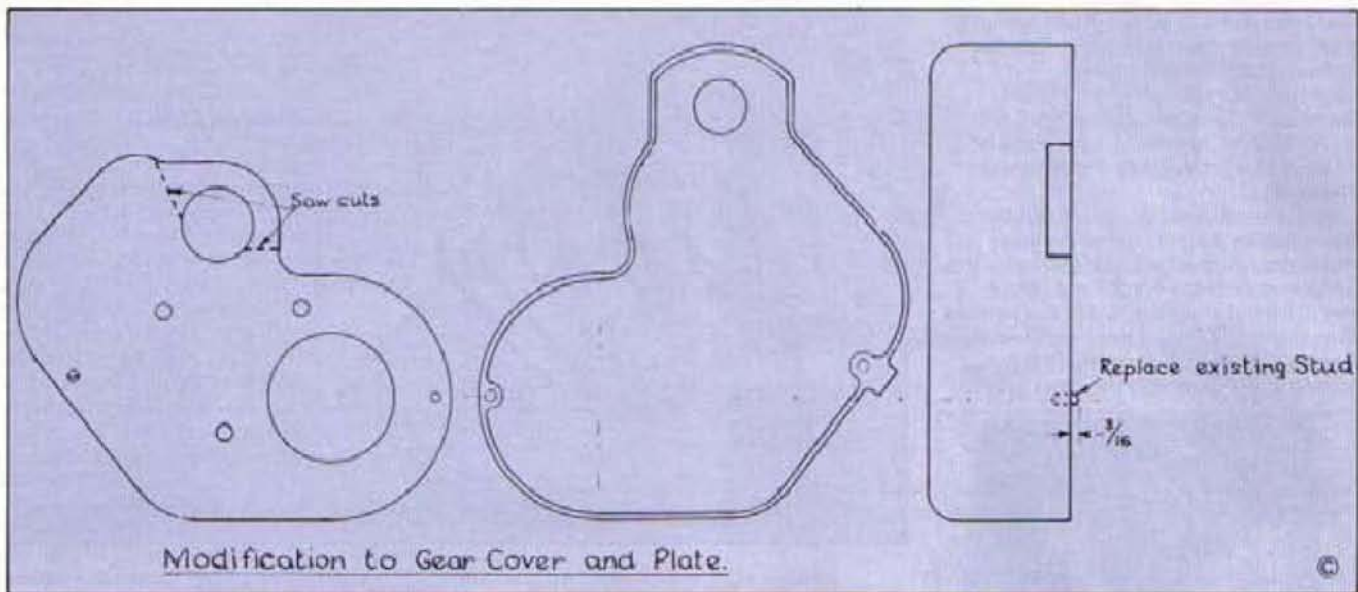
Let it be admitted at the start, to adapt the leadscrew is not a straightforward job. It is simple, yes, but not too easy. First, determine as accurately as possible the final overall length which is needed to finish up with the leadscrew supported by the bearing in the central pillar at one end and by its standard fixing at the other. Strip the leadscrew of all attached items such as the handle and its driving pin, the bearing block and collar. The length of the leadscrew cannot be accommodated in the standard lathe, so remove the tailstock completely. Using a chuck in which the plain end of the shaft can be set to run true and as far into the chuck as possible, support the shaft in a fixed steady. If the steady bears upon the screwthread this will only be for a short time and cause no damage if well lubricated.

Proceed to reduce the diameter of the shaft near the chuck to give the correct overall length as previously decided and the reduced portion to fit the bearing in the central pillar. Of course, you will not be able to test it against the bearing at this stage but get it as close to size as you can



Above, photo 11. The information plate in thin sheet aluminium is held to the front plate by three screws. **Below left, photo 12.** The assembled gearbox in position with the top plate removed. **Below right, photo 13.** Front view of the finished assembly, easily to hand for the operator.





without going below the nominal bore of the bearing. This reduced portion should be about an inch and a half long, with a sharp shoulder up to the full-diameter portion. Part off carefully – or saw it if you prefer, so that you now have something over an inch of reduced portion, $\frac{1}{2}$ in. plus diameter. Check to see what length of this is needed for the bearing and if the length to the shoulder is correct for the main part. Replace the shaft in the chuck which will now hold it by the reduced diameter, true it up, trim to final size and part off to length.

If it still needs easing to the bearing replace it in the chuck, reversing it end-for-end so that the reduced end now extends beyond the steady and with emery cloth and care ease it down to correct size. With any luck, all that remains is to cut the keyway to take the sliding gear and this is the same as you have already cut in the dummy shaft. (Photo 12)

Having persistently and patiently laboured through to success at this stage we can turn our attention to tidying-up things at the head-stock end. The flat plate casting which carried the gear cover for the tumbler gears needs slight alteration. As shown in the drawing, this means removing the top part which serves no useful purpose behind the top-stud gear cluster. The plate will now bolt into position over the end plate of the gearbox and there will be no room for the normal cover fixing at the front. This is effectively replaced by a locating stud as shown, the cover being retained by the rear stud and clamping screw. The whole assembly takes up little extra room and is quite neat and tidy. The tumbler gears are still needed to drive the first-motion shaft and this must be set up as if for 16 tpi in the usual way. This will give the correct ratios as shown on the information plate.

The information plate

The information plate to show which gear positions are which is made from thin sheet, either aluminium or brass. With normal care the figures and letters can be produced by $\frac{1}{8}$ in. or 3 mm hand stamps. If you prefer, there is doubtless a local engraver who would produce the plate for you; it won't cost the earth and could enhance the finished appearance. (Photo 11)

Your gearbox should give trouble-free service. Mine has operated for some time now. Essential maintenance is easy, as you

Table of data for gears

Number required	Number of teeth	Overall diameter	Pitch circle diameter	
2	18	0.714	0.643	Bore 0.26, Press fit.
4	20	0.786	0.714	2-Bore 0.24, Press fit. 1-Bore 0.375, Press fit. 1-Bore 0.375, and keyway.
6	30	1.143	1.071	4-Bore 0.625, Press fit. 2-Bore 0.625, and fit key.
1	35	1.321	1.25	Bore 0.625, and keyway.
1	38	1.429	1.357	Bore to suit ballrace.
3	40	1.5	1.429	1-Bore 0.625, Press fit. 2-Bore 0.625, and keyway.
1	45	1.679	1.607	Bore 0.625, and keyway.
1	50	1.857	1.786	Bore 0.625, and keyway.
1	55	2.036	1.964	Bore 0.625, and keyway.
1	60	2.214	2.143	Bore 0.625, and keyway.
1	65	2.393	2.321	Bore 0.625, and keyway.
1	80	2.929	2.857	Bore 0.625, and keyway.

All gears $\frac{1}{2}$ in. wide except 38T gear which is $\frac{3}{8}$ in. wide.

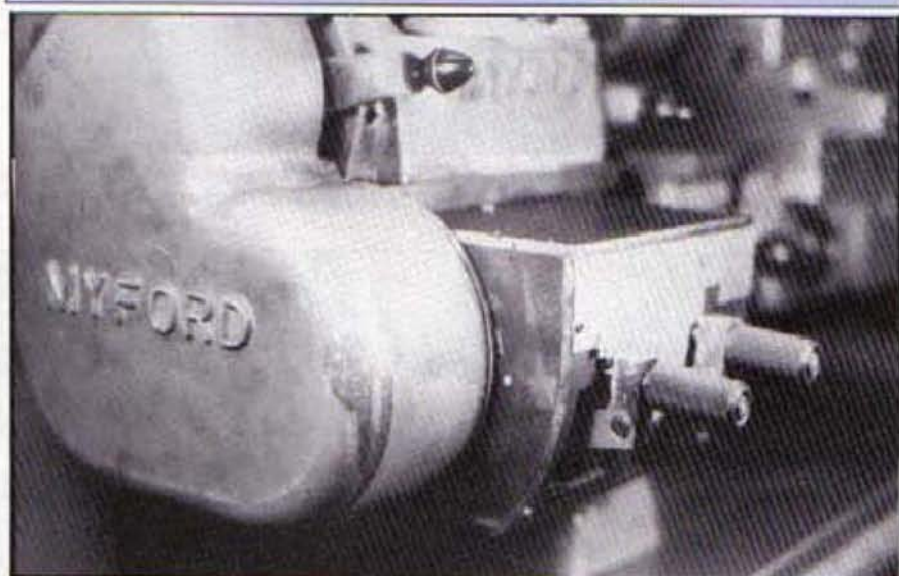


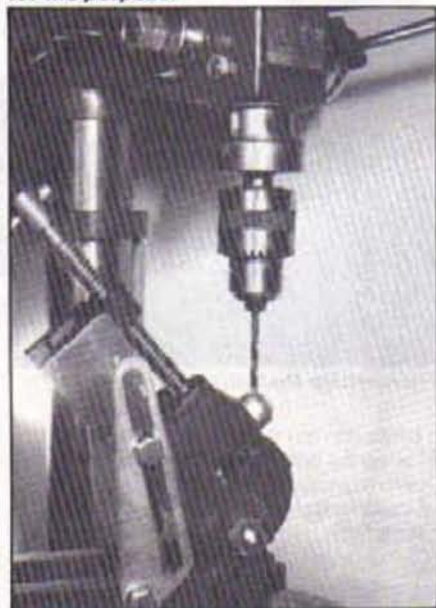
Photo 14. End view of the lathe with the gearbox in position. The gearcover fits tidily back in position.

simply remove the top plate to clean and grease whenever required. Now all your

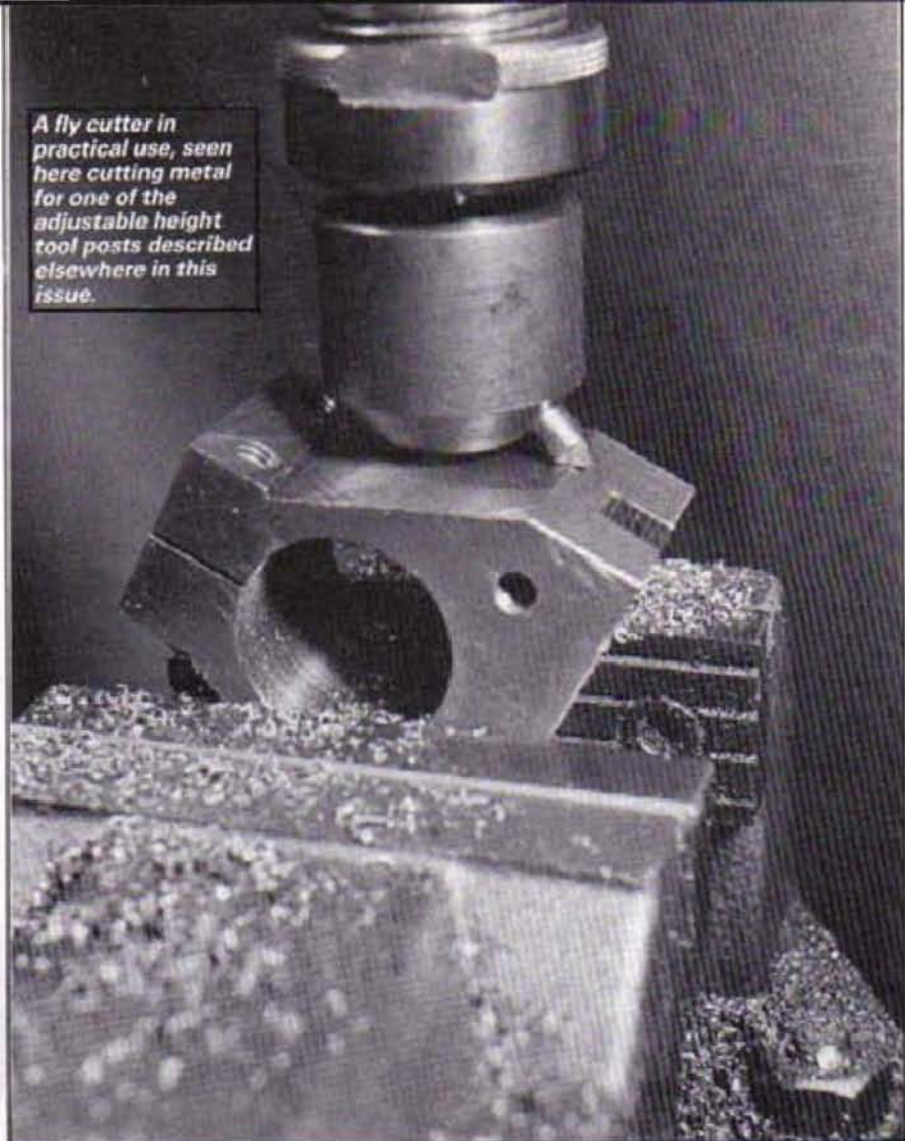
feeds and screwcutting ratios are available at the touch of the levers. (Photos 13, 14)



Above, two typical home-made fly cutters for use in a chuck or collet. Below, the cutting tool must be set at an angle of about 45 degrees; here a hole is being drilled for one, using an angle vice for the purpose.



A fly cutter in practical use, seen here cutting metal for one of the adjustable height tool posts described elsewhere in this issue.



The fly cutter is a most useful piece of equipment, and yet remarkably cheap and easy to make and use. Here we explain the simple construction and give some ideas on how to make and use them

FLYCUTTERS

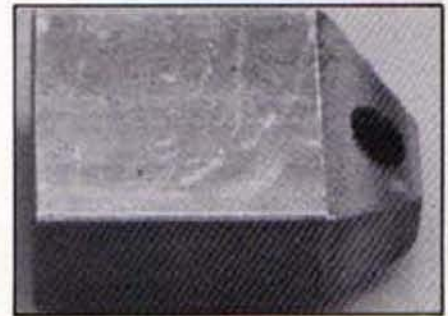
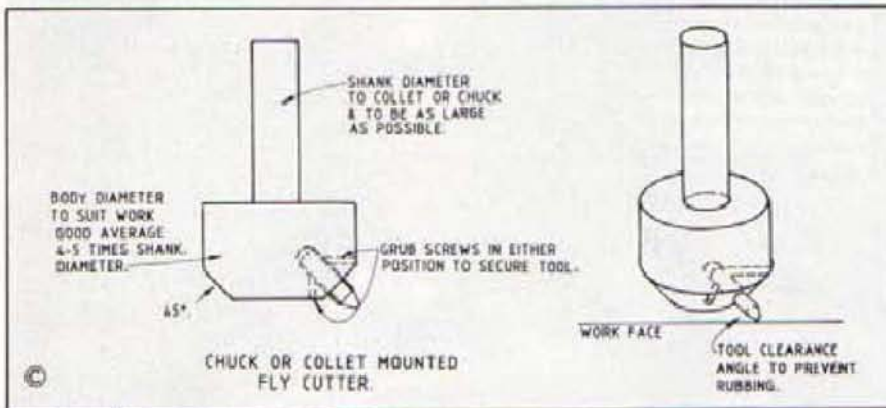


When using a fly cutter in the faceplate the work must be set square; here a casting for a home-made vertical slide has been butted up against the faceplate before bolting down.

The fly cutter is a very useful tool. Properly used it will give a far better finish to work than a milling cutter, and yet it is cheap and easy to make. There is little to remember about the construction of one, other than that the tool itself must be ground to have sufficient clearance to ensure it does not rub at the back. The fly cutter can be used on the lathe or in the milling machine; in the lathe it is possible to fit it straight to the faceplate, thus giving a good wide sweep when cutting.

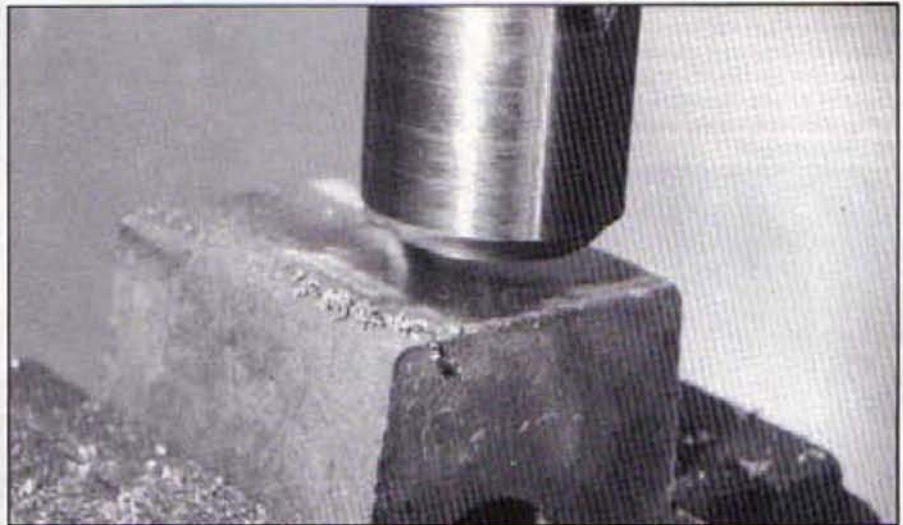
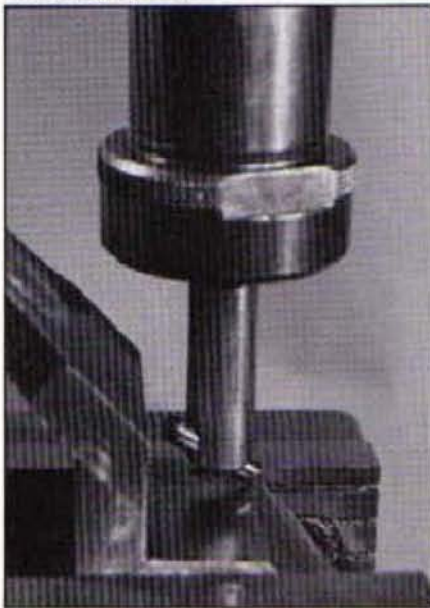
Cutters with shanks

The type of fly cutter used in the milling machine or the headstock of the lathe simply consists of a piece of metal with a chamfer turned on it, and the cutting tool is set in that chamfer. It is roughly 45 deg. to the vertical and is secured in position by a grub screw. Because it is often desirable to have a wide sweep on the cutter it is often made from material too large to fit in the milling collet, and so a shank must be turned on it. This shank can be plain or it can be threaded to fit the collet, if need be. An alternative is to turn a taper to fit the mandrel of either the milling machine or lathe. For obvious reasons, it is as well to have the shank of as large a diameter as possible.



Somewhat different, but just as effective, is this faceplate-mounted fly cutter from rectangular bar stock.

A rather thinner than usual fly cutter is used here to machine a face on the Keats angle plate.



The normal type of collet-held fly cutter used to machine the bolting surface of a model locomotive cylinder.

Cutters for the faceplate

For the lathe faceplate, the fly cutter is made without the shank, being simply bolted through from the rear. As considerable forces are involved in fly cutting, it is desirable to leave a piece at the back of the fly cutter standing proud, which fits into the slots of the faceplate. This should be about half the thickness of the faceplate casting. It will prevent the cutter moving out of place in operation, while allowing it to be well tightened up with a nut. If the boss is too thick, it may stand slightly proud of the faceplate when passed through the slots, and this would prevent the nut from being tightened.

Using fly cutters

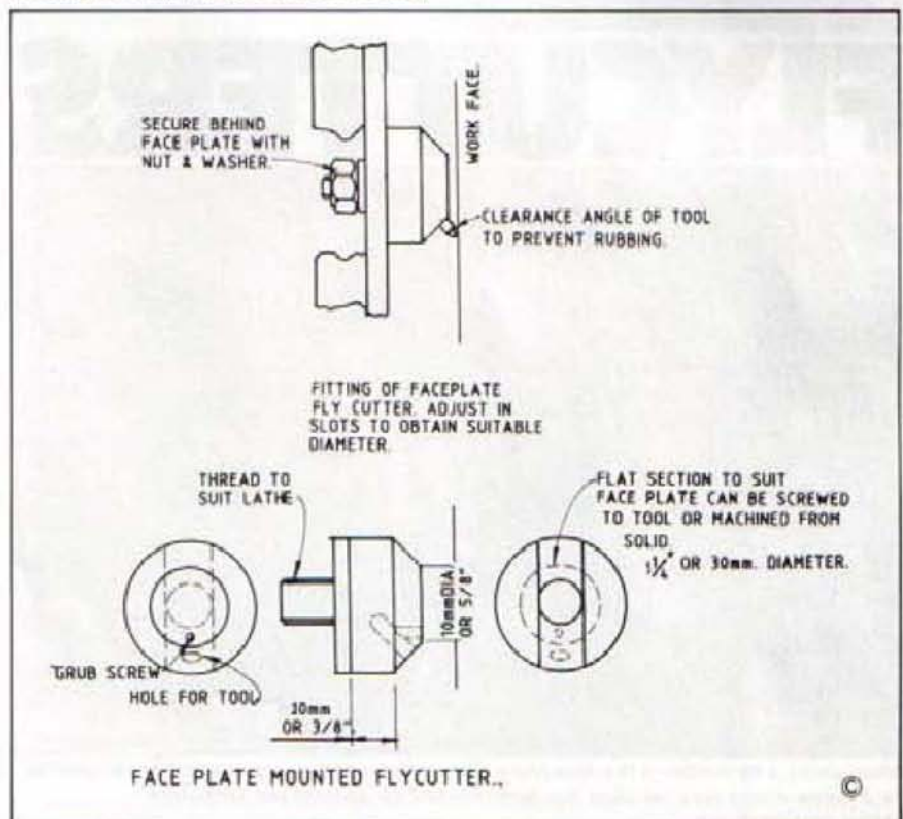
In use, the fly cutter is rotated at a very slow speed and moved very slowly over the work. To newcomers to the hobby, it appears impossible that a smooth finish can be obtained in this way, but as already stated, the finish can be better than with a milling cutter. In spite of the slow speed of rotation, the work is completed quite rapidly because a large area is being machined in one sweep.

When using the fly cutter, every effort must be made to ensure that the work is held securely, and also that it is lined up accurately. If the cutter is being used from the faceplate, then work can be placed against that in order to ensure squareness. In other cases, more orthodox methods must be resorted to.

The cutting tool

The actual cutting tool can be made from silver steel and hardened and tempered. It is better, though, to grind it from high-speed steel. Whilst the steel can be bought in small lengths it is just as easy

to press into use broken end mills, slot drills, centre drills, etc. If there are any broken high-speed taps lying around, these are particularly useful for very small cutting tools.



The power hacksaw described by John Brittain in our first issue has proved one of the most popular articles we have published. The biggest difficulty was obtaining the motor and gear box, particularly as he had used a combination of two units. In this update, John has again been rummaging round scrapyards and has come up with a fairly easily obtainable unit. He now explains how to use it and to get the best from it.

Whilst writing the article on my power hacksaw, which appeared in the first issue of *Model Engineers' Workshop*, I was mindful of the difficulties involved in building a replica, owing to the uniqueness of the two-motor combination and the resultant form which is dictated.

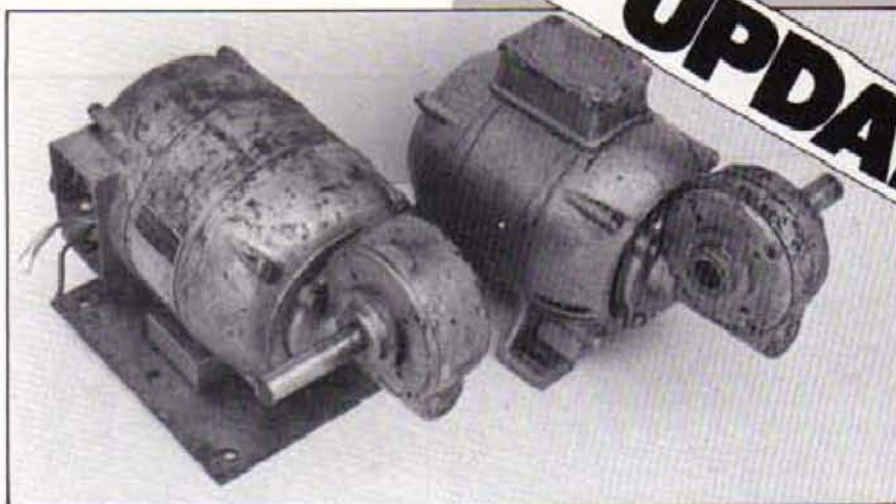


Photo 1. Two geared motors of the kind described by the author; both types are fairly easily available.

A POWER HACKSAW

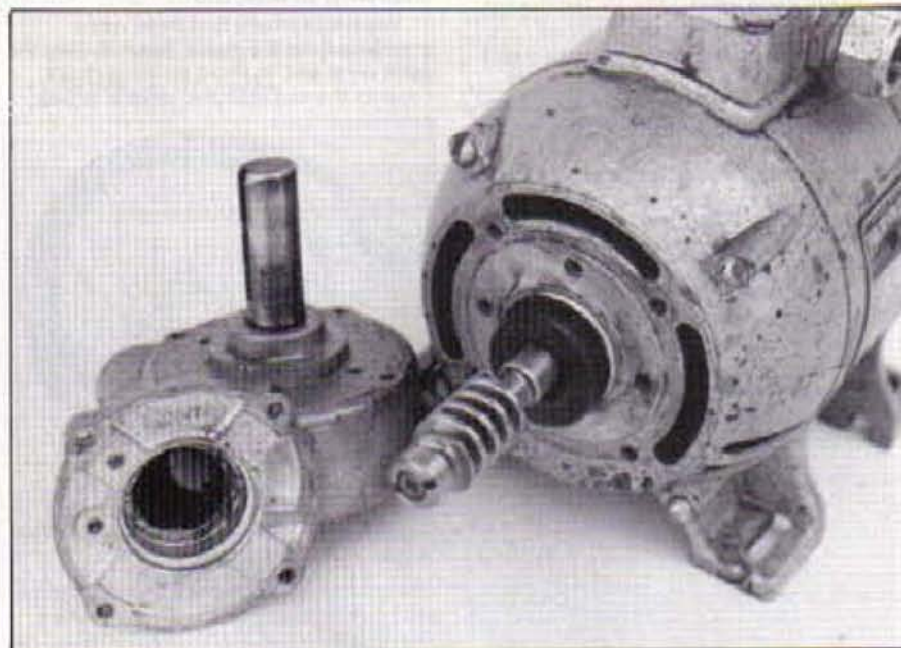


Photo 2. The gearbox of this motor has been removed; the register arrangement can be seen clearly.

The editor pointed out in his preamble, however, that it is possible to obtain suitable drive units on the second-hand market and since I have had some experience with the particular make to which he refers, I thought that a word or two on the subject would not be misplaced.

The Parvalux motor

Parvalux have specialised in manufacturing electric motors fitted with integral gearboxes for years, so that, inevitably, there are many such units to be found in scrapyards and the like, often in perfectly serviceable condition as far as the model engineer is concerned. Two such

examples are shown in **Photo 1**. Now the advantage of this particular design, as applied to the hacksaw project, is that the gearbox can be rotated about the motor shaft and fixed in any one of four positions, thus making readily adaptable for our purpose.

Photo 2 shows the way in which this is accomplished, the locating spigot or 'register', which keeps the worm wheel accurately located with the worm, being clearly seen. Moreover, the 'hand' of the gearbox shaft (i.e. which side it sticks out) can obviously be decided according to which way up the gearbox is positioned. Note that the two motors in **Photo 1** are of

opposite hand. Remember that, for our purpose, the motor base needs to be fixed in the vertical plane, so the gearbox must be turned accordingly, as in **Photo 3**.

Revised 'H' frame

The 'H' frame on my hacksaw was designed to accommodate the main support bracket which was fixed to the gearbox. With a unit which is mounted in the more orthodox fashion, the frame needs to be modified to suit this new situation and diagrams 1 and 1a show how it may be achieved. Note that the gearbox protrudes beyond the frame so as to provide clearance for the crank, since the shaft is no longer in the centre of the frame. Note also that there is room for the gearbox to be turned the other way up if it is of the opposite hand. A dashpot anchorpoint can be provided by a bracket fixed directly to the motor end cover (see **Diagrams 1 and 2**) but make sure that you first remove the cover, or you may damage the windings whilst drilling for the fixing screws.

The two upright frame members can be used to hold the motor if positioned appropriately and drilled for the fixing bolts. The lower horizontal frame member could be extended so as to place the motor further along the base, (see **Diagram 2**) a definite advantage as far as cutting pressure is concerned, but there is not a great deal of latitude for movement in this direction, if you wish to retain the full-size frame. I mention this point because it is, of course, possible to use a smaller saw frame in conjunction with shortened (broken) hacksaw blades. In any case, however, it would be wise to delay making the frame until you have obtained a motor, in order to ensure that everything fits.

Checking the motor

Assuming, therefore, that you have unearthed a little gem at your local

scrapyard, before parting with your money, I would first caution you to check the final drive speed.

Some years ago, I came across a unit which sported a most elaborate gearbox, consisting of a worm and wormwheel which drove the shaft through a mass of spur gears, resulting in a final speed of one revolution every few minutes; fascinating but not a great deal of use to the potential hacksaw builder. Another, which I picked up fairly recently, has a final shaft speed of 30 r.p.m. – tempting, one would think, but not really suitable for our purpose. Again, avoid motors which require 3 phase supply, unless you happen to know how to convert them. Sooner or later however, provided that you are persistent, you are bound to find the motor for which you have been searching; namely, a single-phase unit with a final drive of around 90 to 100 r.p.m.

Testing

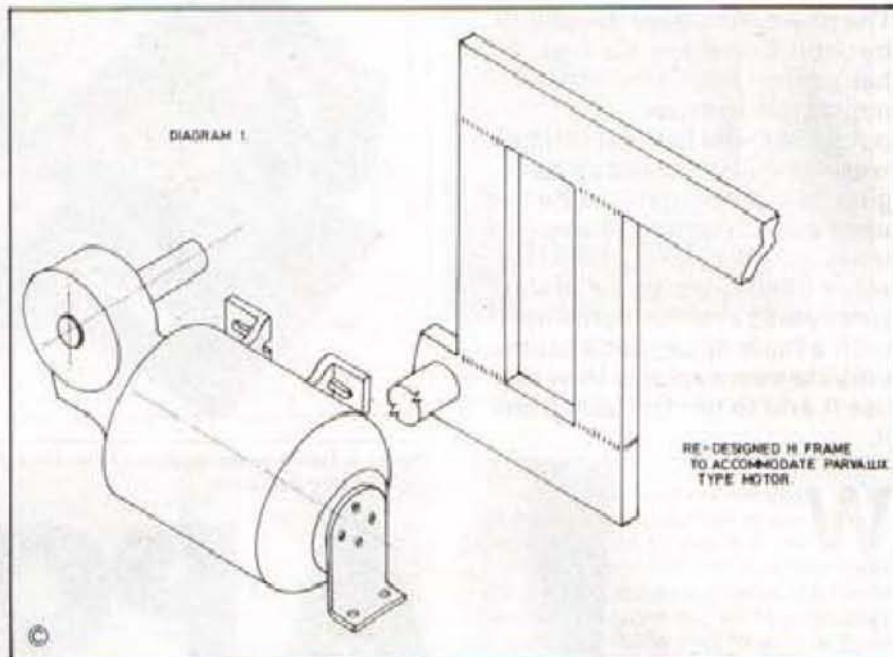
Having brought the motor home and cleaned it up, at this point, and strictly for those whose experience in tinkering with mains electricity is basic, may I issue a few words of warning: **BE CAREFUL!** Temporary hookups are fine, provided that you take adequate precautions to protect yourself, but are lethal if you don't. For example, earthing the unit at all times is essential.



Photo 3. Here, the gearbox has been turned and re-located at ninety degrees.

Suppose that the motor has been discarded because of current leakage to earth; you will discover this fact the hard way if you fail to take precautionary measures.

Likewise, suppose the motor contains



water (not unlikely if it has been lying around on a scrapheap); this again presents a very hazardous situation, so do not attempt to test it electrically until you have given it a chance to dry out. Another most dangerous habit is to twist wires together and leave the connection bare; a momentary lapse in concentration and tragedy could strike, so don't risk it.

The method which I use for temporary testing is to employ a short length of double insulated flexible cable, to one end of which is fixed a plug, whilst the three leads at the other end are attached to small crocodile clips. (see **Photo 4**). Insulation for these clips is provided through the use of rubber shrouds made from the fingers of an old industrial glove. I cut a small hole in the end of each finger, slide one on the phase and neutral leads and attach the clips. When the clips are fastened to a bare wire, the shrouds can be slid down so as to cover the danger area.

I also try to be methodical in my approach by first attaching the earth clip, then the phase and neutral wires before plugging in and switching on. Most important of all, however, is to **SWITCH OFF**

AND UNPLUG before any subsequent tampering with the wiring. As a final defence against the possibility of accidental shock, it's not a bad idea to stand on a rubber or plastic mat; then, if you are caught ignoring the rest of the safety rules, you may be lucky enough to survive in spite of your negligence.

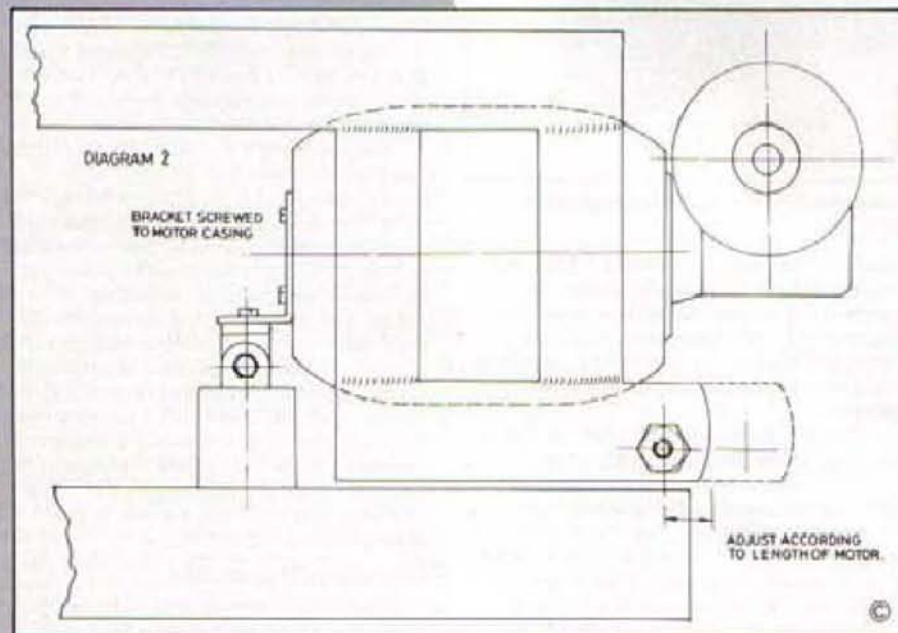
Starting problems

You will normally find three wires emerging from the motor (not including the earth wire) and, to make an initial check, connect the two coloured ones to phase



Photo 4. Temporary test leads; the connections to the motor **MUST** be made before connecting the plug to the mains.

and neutral. Assuming that the windings aren't 'blown', you will be greeted with a buzz but no action. If the motor shaft is accessible (i.e. if you have removed the gearbox) give it a tweak and the motor should run happily in either direction. However, in order for it to be self-starting and, indeed, possess sufficient starting torque, you will need to connect the third (normally black) wire to a capacitor of about 5 to 8 mF. Connect it as shown in **Diagram 3**. In order to reverse the motor, change one side of the capacitor from A to B. For the benefit of those who may not necessarily know what they are looking for, capacitors usually take the form of aluminium-clad cylindrical objects with two terminals protruding from one end, (see **Photo 5**). It is usually possible to find the capacitance value marked somewhere on the casing, once the grime has been wiped off. If you rummage around amongst the discarded

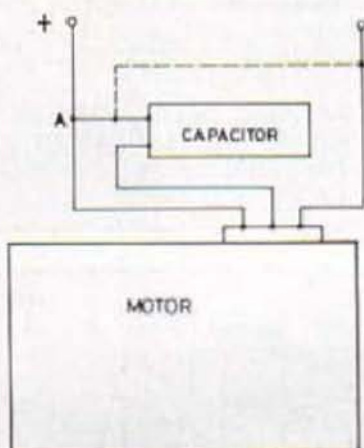


electrical junk, you should be able to find a suitable one without too much difficulty.

Having tested the motor, the question arises as to how the capacitor can be fixed permanently in position. Sometimes you will find a convenient bolt protruding from its base in which case it may be possible to utilize this in conjunction with a suitable bracket attached to one of the motor through bolts. Alternatively, some thin gauge sheet metal (e.g. tinplate or galvanised steel) can be formed in the manner depicted in **Diagram 4**; this method provides both a secure and neat way of joining the two items together.

When wiring the job up permanently, double insulate the wires by binding them

DIAGRAM 3.



CAPACITOR CIRCUIT SHOWING METHOD OF REVERSING MOTOR

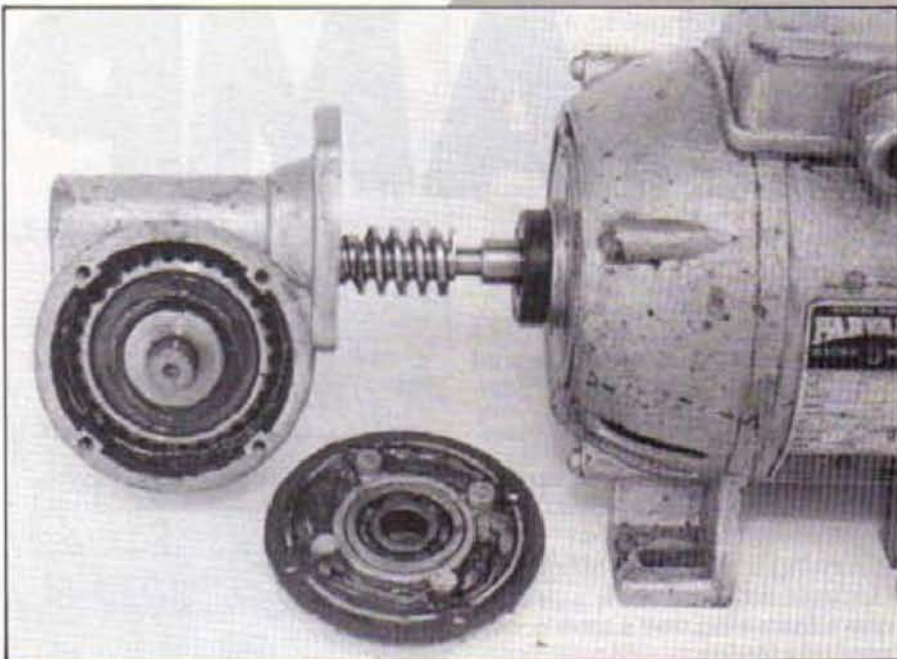
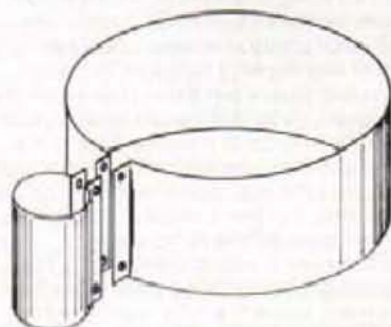


Photo 6. In this shot the gearbox has been removed showing the worm wheel. Good lubrication is essential and the opportunity to apply grease should be taken.

together with insulation tape or, alternatively, employ a length of that plastic tube which shrinks when heated; the use of this material makes a particularly neat finish. In addition to fitting insulated shrouds to the terminals, provide an end cover for the capacitor by scouting around and finding a suitable plastic cap which fits it. Drill a hole through the top of this cap, pass the leads through it, tape the cover firmly in position and, hey presto! the job is done. A number of suggestions come to

mind; if you check in the bathroom, you may be lucky enough to find such an item on top of the wife's hairspray. When she objects to your commandeering it, you can always claim that you are banning CFCs from the house!

DIAGRAM 4.



METHOD OF FASTENING CAPACITOR TO MOTOR USING TINPLATE OR GALVANISED SHEET STEEL



Photo 5. Examples of suitable capacitors; you'll need to fit one of these to ensure the motor self-starts.

Lubrication

A last word concerning lubrication: I have dismantled several of these gearboxes in the past and, in each case, have found a ring of hardened grease surrounding the wormwheel, and the working surfaces as dry as a bone! I would therefore suggest that you either remove the side cover (see **Photo 6**) and repack with grease at fairly frequent intervals or, better still, install an oil nipple in the top of the gearbox casing. Then you can periodically lubricate the very hardworking components with a few drops of gear oil. Obviously, you will need to be sparing with your application of the oil but I think that its use will pay dividends in keeping further wear down to a minimum.

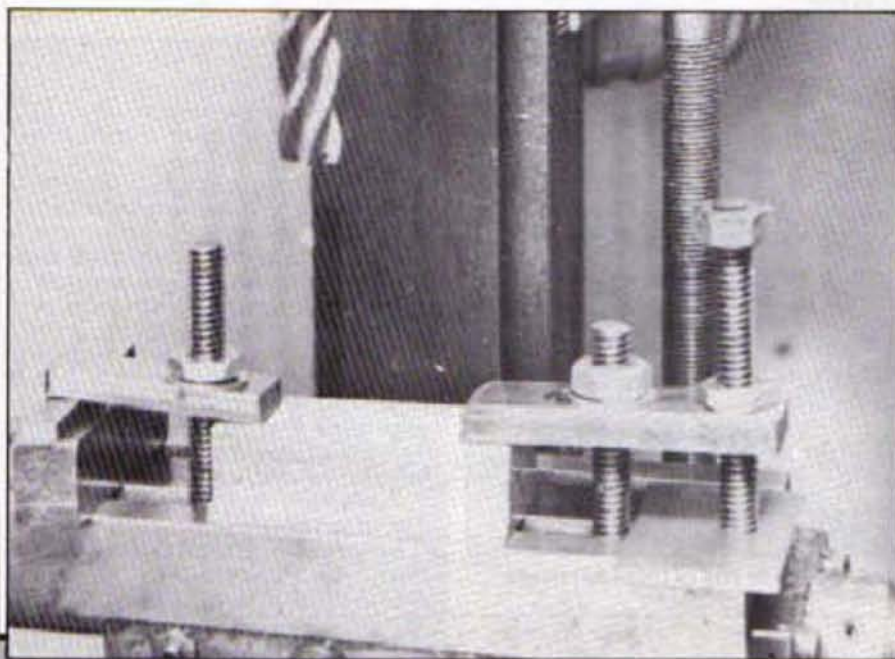
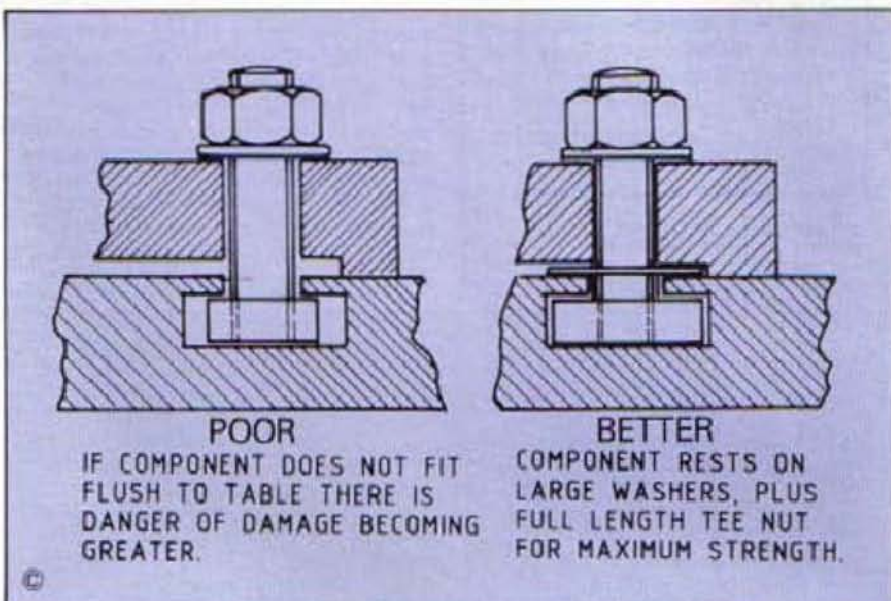
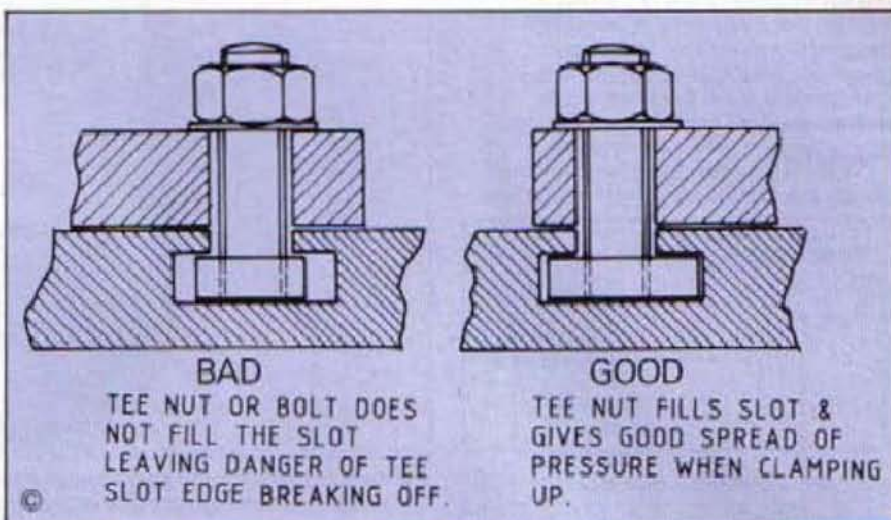
Finally, lest I incur the wrath of the editor, I had better admit to the usual claim of being neither the Managing Director of Messrs Parvalux, nor of some nationwide syndicate of scrapyards emporia!

CLAMP UP!

A very important part of workshop practice is concerned with clamping of work. So important is it considered that a question on the subject seemed almost compulsory in technical exams. The basic principles, which are set out below, are simple enough, and if adhered to trouble will be avoided. This article illustrates normal clamping operations; other features will deal with manufacturing one's own special clamps.

Securing work to a faceplate, drilling table, or milling table is all part of workshop practice. There is nothing difficult about it in normal circumstances, but there are a few things that need to be remembered.

The first thing to think about is the device to which the work is to be held. In the case of a faceplate it will be necessary to pass bolts through the slots and then tighten the clamps with nuts. Whilst this sounds straightforward enough it should be remembered that screw threads when tightened create enormous pressures, quite out of keeping with their size. We must therefore ensure that the section which the nut bears on behind the slot is as large as possible in order to avoid damage to the casting. Large, specially made washers help to spread the load. Some faceplates do not have slots, but just a series of strategically placed holes. Whilst these can be inconvenient in use, at least there is little danger of damage being done when they are used, unless the force used to tighten the nut is exceptional, in which case there is a chance of the thread stripping.

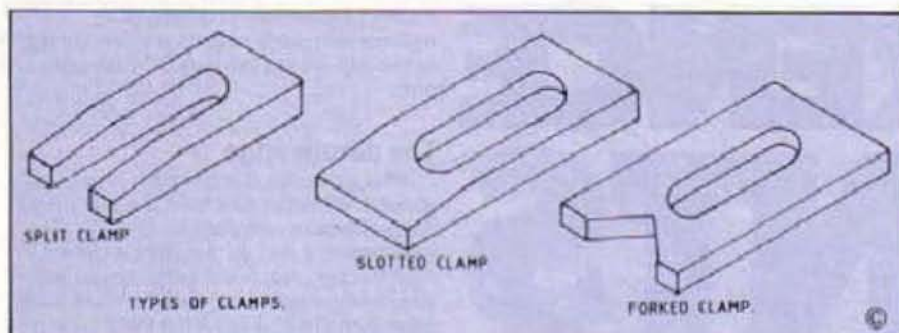


Tee bolts

When clamping work to a table, such as a milling or drilling table, or a lathe's slotted cross slide then usually this will be done with Tee bolts, or Tee nuts into which suitable bolts or studs can be fitted. Here we must ensure that the Tee nut or bolt fully fills the Tee slot. Failure to do this can result in the casting breaking, as the surface area is insufficient to give support. In all cases, as many securing points as is practical should be used to prevent undue strain or distortion on the table. We all tend to think only of the security of the work when clamping it. We must also consider the strength of the machine to which it is to be secured.

The normal method of clamping is to

Two examples of how to get the outer edging of the clamps higher than the work. On the left, packing is used. On the right, an adjusting screw is incorporated in the clamp.



use a slotted clamping bar. The Tee bolt is passed through this and one end is placed over the work. The end away from the work must be supported slightly higher than the height of the work in order that pressure will be directed downwards. Clamps can be bought or made, but they should always be

of adequate length and strength to allow packing to be placed to create the pressure.

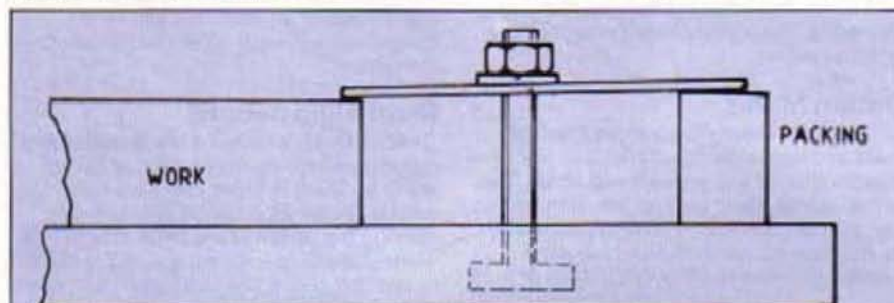
Packing

The packing should not, however, be so high as to make the nut, or rather washer which should always be placed under the

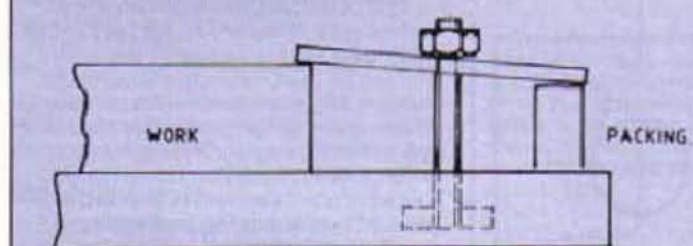
nut, touch the clamp on a small area only. If the only packing available is on the high side then there is no reason why some material should not be placed between the clamp and the work. There is, anyway, no harm in doing this as it prevents marking of the work. The ideal material is aluminium which tends to 'give' under the strain. This allows the clamp to dig in and become very secure.

For work that is rather too high for normal clamping methods swan-necked clamps can be used. These still need packing to allow the pressure on the work to be directed downwards, but they can save using excessively long Tee bolts. Small screw jacks can be used to support clamps away from the work where there is room. These have the advantage of being adjustable and so allowing the angle of the clamp to be shallow enough for maximum pressure. Such jacks are simple to make and last for ever (see page 397). They are worth while making when there is a little spare time. Whilst it is usual to make the base of the jack from round material, this is not always necessary and odd bits of square or rectangular metal can be pressed into use.

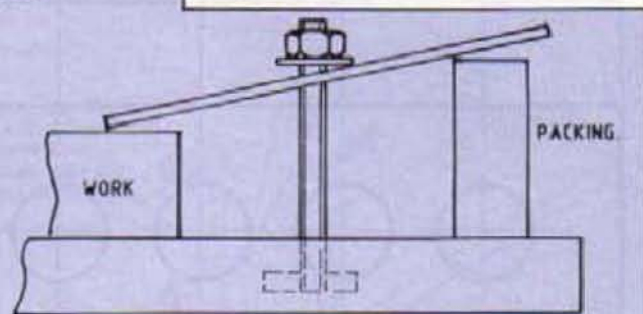
Many people have devised clamps for specific purposes, and for ease of use. Elsewhere in this issue, further features describe two such devices, both of which are extremely useful.



PACKING BETWEEN 1.5 & 2.5mm HIGHER THAN WORK. MAXIMUM PRESSURE EXERTED.



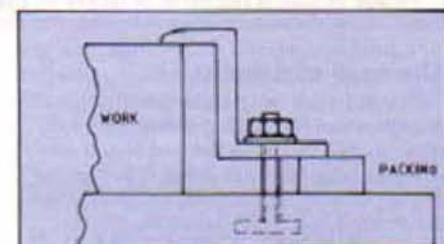
CLAMP PACKING TOO LOW, MINIMUM AREA OF PRESSURE ON WORK, MAXIMUM ON PACKING.



PACKING TOO HIGH:- DIFFICULT TO APPLY PRESSURE ON THE NUT.



A selection of typical Tee nuts and Tee bolts.



FOR HIGH WORK CONSIDER THE USE OF A SWAN NECKED CLAMP. THE PACKING PIECE MUST BE JUST HIGH ENOUGH TO TIP TOP OF CLAMP DOWN.

Quick Tip

After thoroughly cleaning the lathe or milling machine, spray it with silicone furniture polish, preferably giving two coats. It then becomes much easier to wipe off grease and oil, and less cleaning time is needed in the future.

REFERENCE POINTS

The use of datums is essential if good engineering practices are to be followed. This article explains what a datum is and how to use it as an aid both to better marking-out and better machining.

Meaning of Datum

The word 'Datum', according to the dictionary, means 'something given or admitted, especially as a basis for reasoning and drawing conclusions.' A second meaning is also given as 'Something used as a basis of measuring or calculating.' Both descriptions apply equally in engineering. It is a fixed point or place from which we calculate to reason out a design, and equally a fixed point from which we measure, or move the working parts of our machines.

intervals we simply measure 10-20-30-40 and so on. Any error will only be that caused by inaccurate measurement of one of those marks.

Datum Marks

Suppose, however, we make our first mark and then measure 10mm and from that another 10 and another and so on. This is fine except that if we happen to make, say, a $\frac{1}{100}$ of a millimetre error on each one, by the time we get to the end we are a whole millimetre out. Using the first

method if we make a mistake of $\frac{1}{100}$ millimetre on each one, then when we get to the end we are still only $\frac{1}{100}$ millimetre out.

The datum edge

Of course, this is still not the way to go about it. Why measure from the first mark? We may have made an error in the measurement and so that will be carried right through. No; much better to use the edge of the metal which is a far more fixed point than our first line. That fixed edge is our datum.

If we are drawing lines along the metal at ninety degrees to the measurement, it may be different. The edge from which we first measure may be uneven or at an angle. In that case, it will make sense to use our first mark as the point to work from. The mark then becomes the datum. So we can use either an edge or a line as the datum, taking care to select whichever is the best.

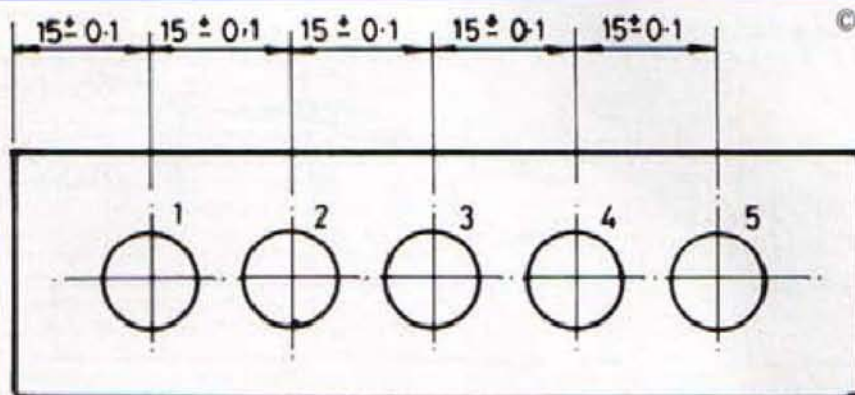
Centre line datums

Another time where a line is useful as a datum is where circles or parts of circles are to be used. In those cases we have what is known as a 'centre line' going through the centre of the circle. It is difficult to measure right across this and it is as well to use that centre line as a datum and work each side of it. After all, the datum is a fixed point or line, but nothing says we only work on one side of that datum.

Datum surfaces

One of the best forms of datum is a surface plate. If readers do not have such a thing, then there is usually an alternative that can be used. Plate glass in particular makes a very good surface. We are now, of course, going to use our surface plate as a datum for marking-out. This is the most accurate form of marking-out we can do. The work is put securely on the surface plate and all measurements made from that. The methods used vary, but an easy way is to use it in conjunction with an angle plate and a scribing block.

Other instances of using a datum surface is where measurements are taken on work in a lathe or a vice. The lathe chuck

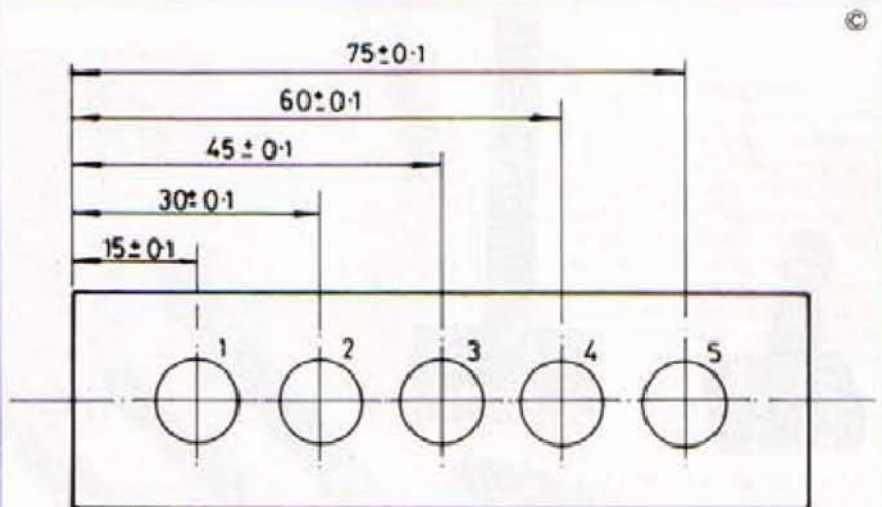


By marking hole centres from the previous centre a multiplied error can occur. If each of these hole spacings is as little as ± 0.001 in. then the final hole will be ± 0.005 in. out. If the error is ± 0.010 in. then the final error will be almost $\frac{1}{16}$ in.

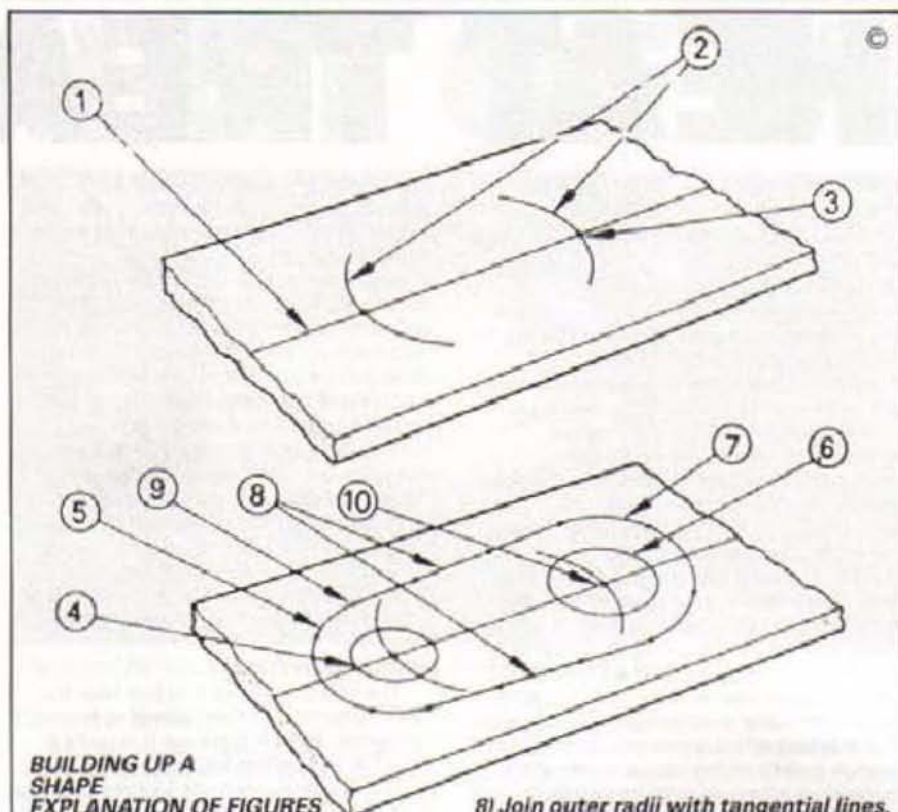
The uses of datums

A datum will be used by the draughtsman for making drawings. It will also be used by the woodworker and we shall see how both use it. For the engineer, it takes on a wider meaning as more datums are used in engineering than in either of the other two cases. All this sounds very fine and scientific but does not say exactly what a datum is, other than as a generalisation. This is right, because a datum can be any fixed point.

We use the datum mainly to avoid cumulative errors – for example, we will use it when marking-out metal. The actual fixed point we use as the datum is of no real consequence, save that the more secure the fixed point the better. Suppose we want to make a series of marks along a strip of metal. We can start by making a mark a certain distance from the edge and then use that to mark off the others. We must not measure each one from the nearest, because that is how errors accumulate. All must be measured from our first line. If we want them at 10mm



All measurements are taken from the datum edge on the left hand side of the work. An error of 0.001 in. remains 0.001 in. on any opening, an error of 0.010 in. likewise remains at that figure on any one hole centre.



BUILDING UP A SHAPE

EXPLANATION OF FIGURES

- 1) Centre line scribed on work.
- 2) Mark off centres using dividers.
- 3) First hole centre.
- 4) Prick punch centres and scribe in radius of hole with dividers.
- 5) Radius of small end of link.
- 6) Scribe radius of second hole using dividers.
- 7) Outer radius.

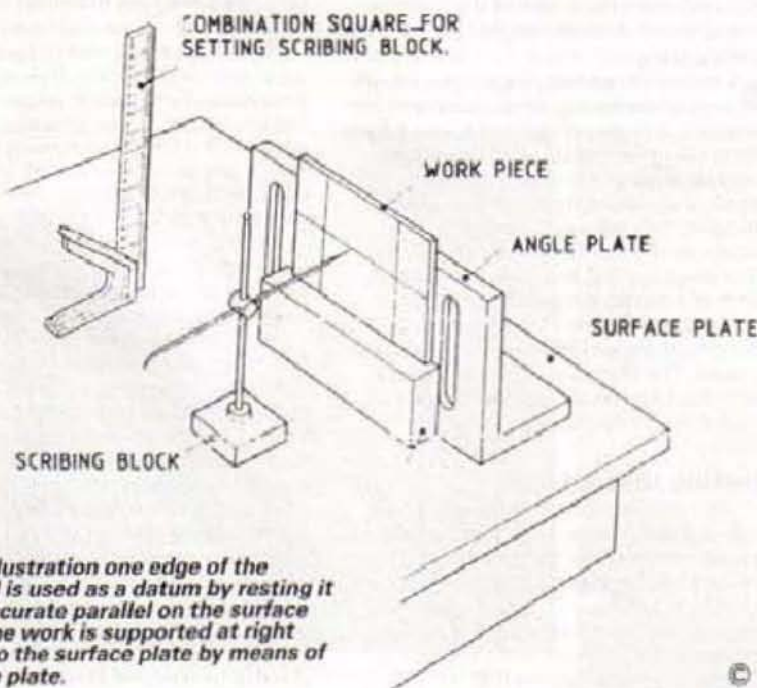
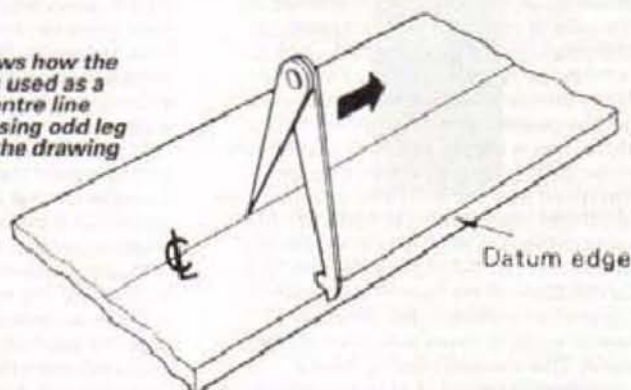
- 8) Join outer radii with tangential lines.
- 9) Prick punch outline of link.
- 10) Enlarge hole centre marks with centre punch ready for drilling.

or faceplate can be used as can the top of the vice jaws. The same system goes – take all measurements from the one fixed point.

Multiple datums

Sometimes we need to use two datum points, because we have measurements going in different directions. This is fine;

This illustration shows how the edge of the material is used as a datum to scribe the centre line along the workpiece using odd leg calipers. As shown in the drawing above, the centre line can now be used as a datum from which to build up the outline of the part to be marked out.



In this illustration one edge of the material is used as a datum by resting it on an accurate parallel on the surface plate. The work is supported at right angles to the surface plate by means of an angle plate.

even though one datum may be an edge or a surface, while the other is a line, stick to the same principles and all will be well.

Machine gradations as datums

There is one other type of datum we will use, and this is equally important. It is the gradations on the machine itself. These are far more accurate than any measurement we can make by eye, and should be used at all times where possible. Suppose we have some holes to be drilled in a strip of metal. If the metal is put in the milling machine vice, which we assume has been properly lined-up, then using a centre drill in the milling collet or chuck we can get highly accurate spacing of the holes. This is done by using the gradations on the dials. Decide the starting point and then work from these counting the measurements as the dials rotate. Providing the handle is not reversed at all during operations, the marks will be accurately spaced. If for any reason it is reversed, then we must return back beyond our starting point and make a fresh start. This is essential to take up any backlash in the screws. In this case, we are using our starting point on the dial as the datum. If it is resettable, the reading should be adjusted to zero.

Good marking-out is essential for good workmanship and the use of datums is essential for good marking-out. Whenever

any such operation is being carried out, the first thing to do is find a suitable datum and start from there.

QUICK TIP

A tip from Mr A W Stirling of Orpington: Re quenching oil. Now that whale oil has fallen into disuse for quenching steel I would recommend soluble oil for this purpose. It can be mixed at any proportion from 100% oil for slow cooling to 100% water for very rapid cooling, and all requirements in between. I have also had good results from a layer of oil floating on top of water to give a two stage quench when hardening home-made button dies. For some reason, brine is reputed to give better results than fresh water. Does anyone know why?

The heat treatment of metals (softening, hardening and tempering) is a subject at which the home workshop operator must find him or herself at a disadvantage to the professional. A few tips are contained here that might prove to be of assistance to those to whom the subject is something of a mystery...

The heat treatment of metals is done mainly for four reasons:

1) Normalising

This process is used to refine the structure of metal after it has been distorted by being worked in the cold state. When metal is produced, it is brought to shape under intense heat. The actual section can be cast, drawn or rolled, but in all cases it involves raising the temperature of the metal until it is very ductile. The cooling down of the material builds up inner stresses. How great those stresses are will depend on the type of material in use, but invariably they will be present.

Distortion of metal

If the metal is machined or worked in any way then those locked-in stresses become critical and the material will try and relieve the strain set up within itself. The result may well be that after a period the material will twist or bend away from the shape to which it has been machined. In the case of cast iron, these stresses can often be relieved by leaving the casting outside in the elements for a long while. Many people when buying castings like to get the cleanest one the supplier has in stock. This is wrong. The best castings are those covered in rust. When they are machined they are less likely to suffer from any major stress changes. Even getting old rusty castings is not the final answer and further stress-relieving or normalising may be desirable. In the case of mild steel and some other materials, the only way to relieve those stresses is by normalising the metal. This involves heating it for a considerable period of time to quite a high temperature and then leaving it to cool down slowly. The temperature required is quite high and the metal should be near a dull red colour during the period of heating.

Black mild steel is less inclined to need normalising than the bright steels. Whilst black steel does not look as good as the bright finish type, it has many advantages for some work. When machined, the finish can be quite good and it is a material well worth considering for many operations. Model locomotive frames, for example, are far better made from black steel than if bright unnormalised steel is used.

2) Annealing

In common language: softening of metals, and applies particularly to metals that are prehardened, and also to some non-ferrous metals. The name of the process is self-explanatory. To soften metal, it needs to be heated to a bright red colour and then, in the case of steels, left to cool slowly or with brass and copper it can either be left to cool or can be quenched in water. Most metals tend to harden with work, and some non-ferrous ones will harden with time alone (especially certain aluminium alloys). When working with such

HEAT TREAT

materials, it may be necessary to soften them several times during operations. Aluminium alloys require a slightly different treatment.

3) Hardening

Steel with more than 0.3% of carbon in its make-up can be hardened by heating to above 750 deg. C and then rapidly quenching. This is the process we can use for making tools and for other purposes. Steel with less than the 0.3% carbon content cannot be hardened by these methods. In the home workshop, it is not always possible to know the exact temperature to which material has been raised, and so we must rely on visual means. Basically, this involves heating the steel to the correct temperature and then quenching it. Whilst water will do in many cases for this purpose, oil gives a better result as the slightly slower cooling rate prevents the material from cracking, as is likely with water quenching. The reason for this cracking effect is interesting. When we plunge a piece of hot steel into water the outer shell is immediately cooled right down, and becomes a hard metal skin. The inner part, however, remains red hot and soft. This cools an instant later and sets up stresses which causes it to expand. This expansion causes the now brittle outer shell to crack. Knowing why such cracking takes place can help us when hardening tools to prevent the effect to some degree. More important still, we can take steps to prevent the tendency for the material to warp as sometimes happens.

If we heat a length of carbon steel of comparatively thin section and then lay it in the water so that the whole length is quenched at the same time, the stresses set up will cause the metal to warp. This effect can be minimised by plunging it lengthways into the water. The part that is to form the main cutting section going in first. The stresses no longer go sideways, but travel along the length of the material making warping much less likely.

4) Tempering

A means of reducing the brittleness of the original hardening. When steel is hardened, it is very brittle and to use it for a tool to cut other metal would result in it chipping away at the edges. We need therefore to reduce the hardness whilst at the same time leaving the metal tough enough to use as a cutting tool, or for some other purpose. This involves reheating the metal to a certain temperature and again cooling it rapidly. The initial hardness is now drawn out and a toughness has taken its place. The temperature to which the metal has been heated will decide on how tough it is and the purpose for which it is suitable.

Heating the material

The home workshop enthusiast is at a distinct disadvantage when it comes to heating metals to the temperatures required for any of the above processes. In industry, the metal is placed in a furnace, frequently called a muffle, this is raised to the correct temperature and the metal is left in it until it too reaches that temperature. This is as a rule worked out by

the volume of material. The person working at home is unlikely to have any such refinement and so must make do as best as he or she can.

It is then usual to rely on the colour of the metal as a guide. There is one other difficulty, however, and that involves the heat source itself. As a rule, a blowlamp must suffice and this usually will only heat a portion of the metal. If we start at one end and get that to the required temperature, then move the blowlamp along, by the time we heat the other end the temperature will have dropped at the point where work first started. It is, therefore, a good idea to make an open, fronted oven from refractory fire brick and play the flame backwards and forwards in this in order to get a good overall heat.

Visual observation

The only other way is to just heat the working section of the material to be hardened, if this is possible. It is quite a practical suggestion for things like chisels and screwdrivers, but not so easy with say a small press tool, where overall heating is essential. As far as the correct temperature is concerned, we are again at a disadvantage and must rely on observation. If steel is heated to the colour of a boiled carrot before quenching then it is approximately correct. Heating it beyond this point is of no advantage. It will not make the material any harder. The colour of heated material will appear different to the eye, according to the light in which it is viewed. If seen in complete darkness it will appear brighter than on a sunlit day. Whilst subdued light is recommended it must mainly be a case of relying on experience to get the colour correct.

When it comes to tempering, we are in the same position and again must rely on visual observation and the changing colour of the metal, no temperature check being possible. If we have hardened the steel, it will be a black colour and so we will be unable to see any colour changes unless it is polished bright again. This brings us to two points: Firstly, when preparing steel for hardening, get it to as smooth a finish as possible. If it has file or turning marks on it, then trying to polish it is difficult, as it is not possible to get into those marks, and this will make it difficult, if not impossible, to check any colour changes. Whilst a good finish is still essential, soaking the metal in washing-up liquid prior to hardening does make it easier to clean up for tempering.

If the metal is to be used for a cutting tool, it is possible to heat the end away from the cutting edge and watch the changing colours flow along the metal. When the correct colour reaches the cutting edge it can be quenched. If more than the cutting edge is to be tempered, the metal must be heated as a whole. There are several ways of doing this. Laying it on a bed of sand heated from below is useful. The colour will spread over the whole metal evenly. A similar effect can be obtained by heating a piece of metal plate, say 1/4 in. thick to a red heat and leaving the piece to be tempered on that until suitable colour changes take place.

SMALL WORK HOLDING CLAMPS

Finding suitable clamps and clamping methods is always something of a problem. There are many ways of going about it. In this well illustrated article Bob Fletcher describes a neat clamping arrangement which he uses in his workshop and which ensures that the pressure on the work is in the right direction. Samples of these little clamping devices should find a place in every model engineer's workshop.

The clamps shown in the sketch have been made up for use on a Pinnacle Excel milling machine. The dimensions shown on the working drawings can be altered to suit any machine or workpiece. Any number can be made, but I have found four to be an ideal number.

Item 1

This item is no more than a tee nut, made a little longer than normal with two tapped holes instead of the more usual

one. A length of $\frac{1}{2}$ in. $\times \frac{3}{4}$ in. mild steel stock is set up on the milling table and machined to the dimensions shown on the working drawing. The workpiece is then clamped to the drilling table and the two holes drilled and tapped 2BA, or 5mm if you are a metric person.

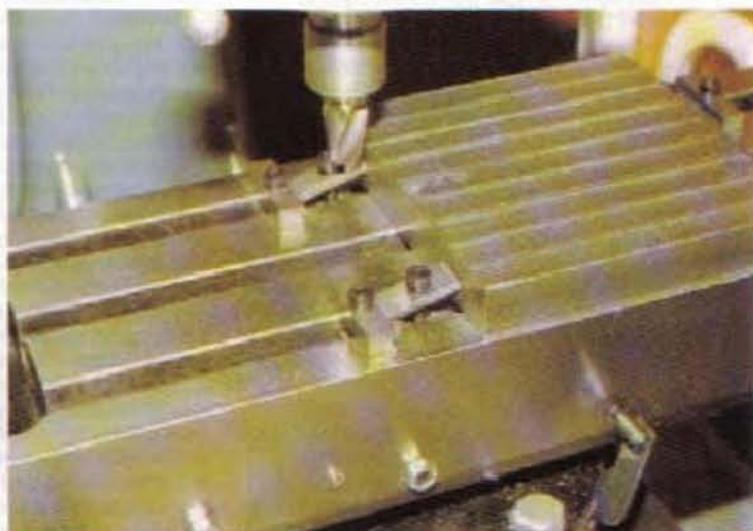
Item 2

When this piece is positioned and tightened, it acts as an anvil for the clamp plate to push against. A piece of $\frac{3}{8}$ in. square steel stock is used and milled to

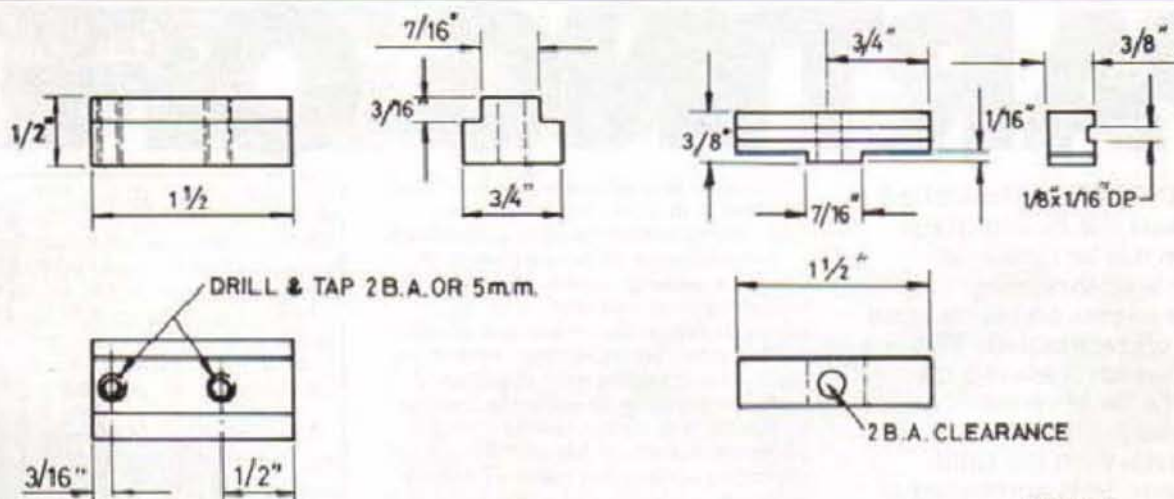
size. The small spigot on the base of this anvil should fit the slots of the milling table in order to prevent the piece from turning when the fixing bolt is tightened. The slot milled on the length of this piece is to locate the clamping plate.

Item 3

This item is used to clamp the workpiece, and the dimensions and can be made to suit the work in hand. From time to time different sizes will be required. The dimensions on the working drawing I have



Top left, photo 1. This illustration shows a square work-piece held up against the fixed bar. Top right, photo 2. This shot shows the wedge clamps in position at the other side of the work-piece. Above left, photo 3. Here four clamps have been used to hold a circular work-piece. Above right, photo 4. another view of four-clamp operation employed during the milling of a circular piece of material.



ITEM 1

WEDGE CLAMPS

ITEM 2

found to be most useful for my own purposes but I have made sets of them thicker and longer with shaped ends to fit a particular casting etc, alternatively gauge plates could be used. A length of $\frac{1}{4}$ in. by $\frac{1}{2}$ in. flat mild steel bar is cut to size. The 2 BA clearance hole is then drilled and filed to a slight slot to give enough clearance for it to rock on the clamp bolt.

Items 4 and 5

These are standard commercial socket head cap screws 2BA by 1 in. If you must use metric you will be able to use 5mm by 25mm.

Item 6

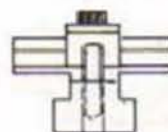
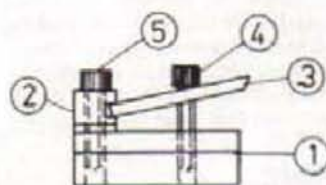
This is an addition which I have found useful when the workpiece has a straight edge to work from, in this case it is made from $\frac{1}{2}$ in. by $\frac{3}{4}$ in. mild steel stock and two holes 2 BA clearance are drilled to match the slots in the machine table. The front edge is milled to a slight angle to give a better grip and also to force the work down onto the table. The same two Tee nuts, Item 1 and clamp bolts, Item 5 are used to clamp the bar down to the table, it is set square to the table by using a try square.

To use the clamps

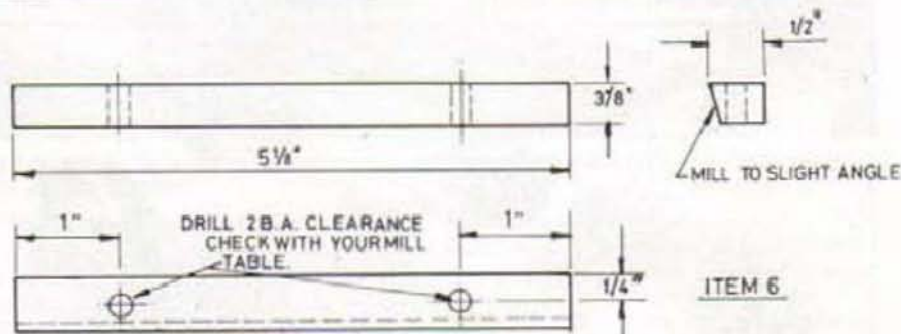
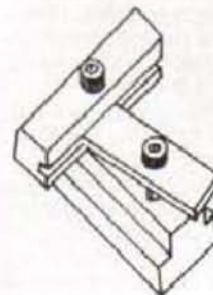
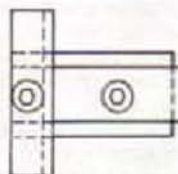
The workpiece is placed on the milling machine table and pushed up against Item 6, the clamps are then pushed up to the work and cap screw, Item 5 tightened. The cap screw, Item 4 is then tightened to wedge, Item 3 against the workpiece. It will be found unnecessary to overtighten cap screw 4, just a steady nip is all that is required. I have used the same principle but of different design to hold work to the faceplate of the lathe.

Just a word of caution to newcomers to machine work. It must be realized that in this set-up the workpiece is not directly bolted to the mill table or face plate and a slower speed and lighter cuts are recommended in the interest of safety.

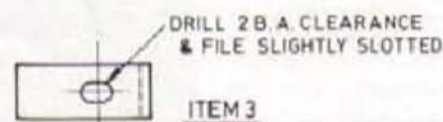
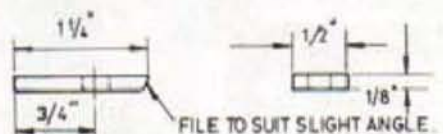
On the subject of safety, it is good practice never to stand in line with the faceplate or milling machine when starting up a machine. Standing to one side is definitely a good habit to get into, it will save the embarrassment of explaining to your family and colleagues the recent acquisition of a black eye, if nothing else.



SKETCH OF
WEDGE CLAMP



ITEM 6



ITEM 3

PARTING OFF METAL

Ted McDuffie from the United States was the author of the article in our last issue on variable lead threading; in this issue he passes on his ideas on parting off techniques. This is a subject which is always the cause of a lot of concern, even with some professional machinists. With the right equipment, be it purchased or home-made, and with the correct methods it should hold no fears. Read and digest Ted's words of wisdom and see how the experts go about it!

Home workshop lathes are seldom used to their maximum mechanical capacity and most hobby work requires turning that is well within the capacity of small lathes. One exception is when a small lathe is used for parting off large round stock. With average parting off tools and a small lathe, light cuts are the rule. Many lathe users have blamed lathes for poor performance when the problem was actually in the parting off tool blade or holder. More problems are encountered in using the parting off tool than any other single point standard lathe tool.

For parting off metal up to about 1 in. dia. a parting off tool ground from regular square tool stock is very satisfactory. Contours such as special screw-end shapes may be ground on the same tool stock and be combined with the parting cut. The width of the blade should be related to the diameter being cut so that as little metal as necessary will be removed. It should be just wide enough to provide rigidity. As an example we might make a parting off tool for 1 in. stainless steel $\frac{1}{8}$ in. wide, whilst for

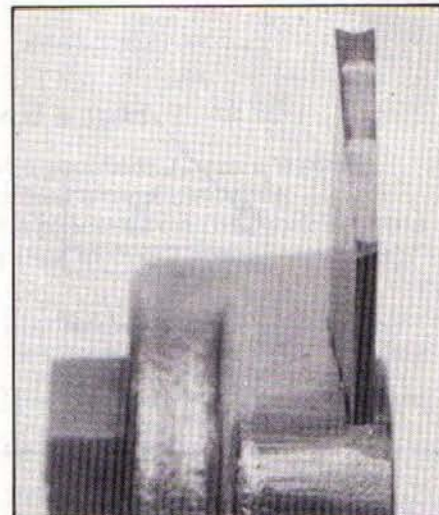
$\frac{1}{8}$ in. brass, $\frac{1}{32}$ in. is adequate. The less metal removed, with other factors equal, the faster and smoother the parting off will be.

For general cut-off work a parting off blade in a holder is more practical than a tool ground from tool stock. It can be adjusted in the holder so that just enough blade is extended to pass the centre of the stock. As with ground tools, the width of the blade should be as narrow as practical for the depth of the cut. Small $\frac{1}{2}$ in. height blades are available in widths from $\frac{1}{32}$ to $\frac{1}{8}$ in. top cutting surface. Tool holders for small lathes come in various sizes requiring blade heights from $\frac{1}{2}$ to 1 in. A good quality blade of high speed steel is well worth the difference in price, because the heat generated from friction can damage a carbon steel blade very quickly. If you have the misfortune to break a relieved high speed steel slitting saw blade, excellent parting off blades may be made from the broken blade. For parting off small bushing stock, used in clock plates, I have found single edge razor blades to be a good source of steel. Small bushing stock parts off easily without side relief on the parting off blade.

Parting off metal

A parting off tool must be properly mounted for satisfactory results. Any looseness in the holder or the lathe slides between the cutter and the lathe bed will cause chattering. There must be good contact surfaces between the blade and the blade holder and between the blade holder and the lathe.

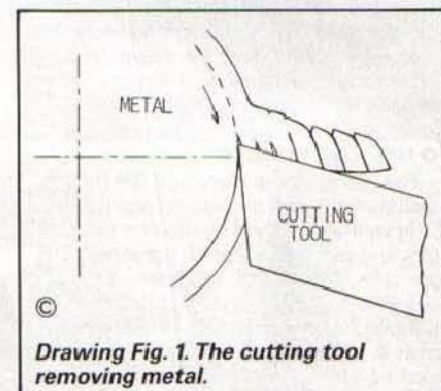
Parting off blades should be relieved on the end cutting surface and on the sides, as the blade must cut three surfaces of the stock. A 10 deg. end relief is adequate although many prefer slightly more. As the end relief is increased the cutting tip is weakened so use 10 deg. of relief for hard metals. A greater vertical dimension of the blade increases rigidity so blades with



Photo, Fig. 2. End view of the parting off blade.

more height are preferred if the lathe will accept the larger holder.

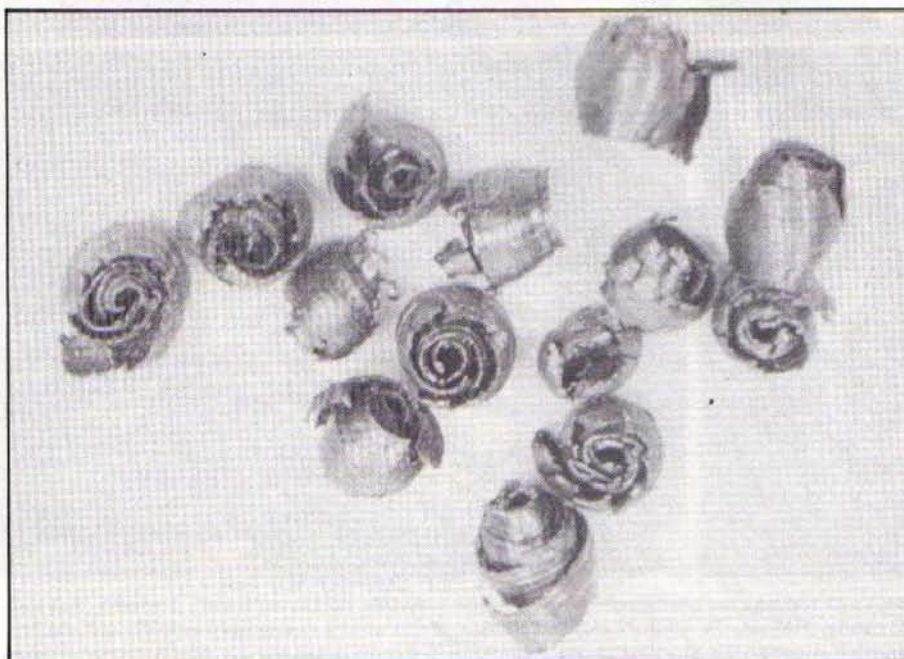
These blades should be set at lathe vertical centre height with the top of the blade parallel to the cross slide. If the blade is on vertical centre and there is movement of the blade under extreme cutting pressure, the blade will move away from vertical centre and take a lighter cut. On the other hand, if the cutter is set above centre, flexing under pressure will increase the depth of cut and overload the tool or produce an irregular cut. The blade should be parallel to the lathe bed so that the vertical height of the cutting tip will not change if the blade is extended or retracted from the tool holder. It is often necessary to



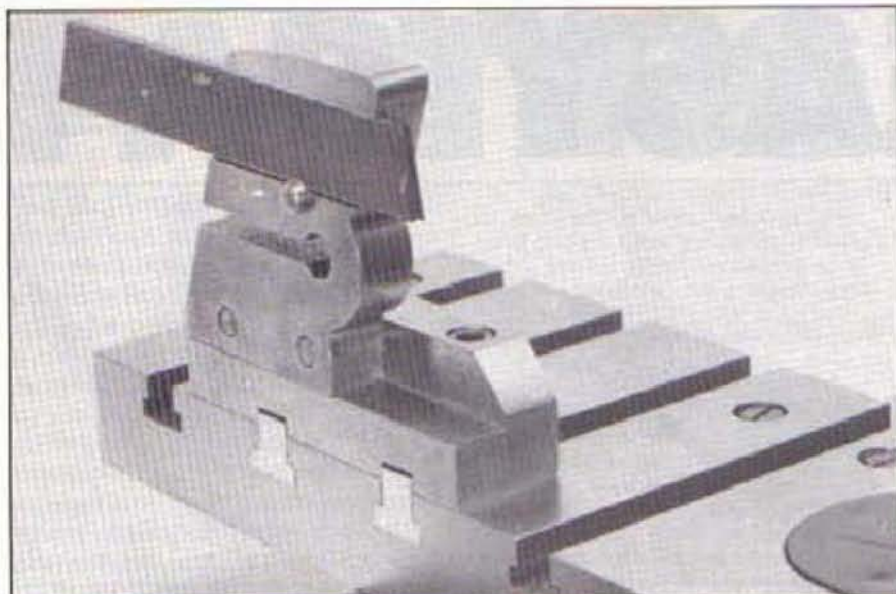
Drawing Fig. 1. The cutting tool removing metal.

extend the blade during the cut, when parting off large stock, and it is difficult to recentre the blade at this point.

Parting off blade holders are designed to centre the thinner following edge of the blade in the slot being cut. Blade holders are made to accept a certain blade thickness and blade height and a shim might be required if a thinner or thicker blade is used. With the blade mounted for parting, check with a machinists square from the lathe bed or cross slide, for equal clearance on each side of the blade. If the clearance is not equal, a $\frac{1}{4}$ in. wide shim of proper thickness may be added between the side of the blade and the holder, either top or bottom, to make the clearance equal.



Photo, Fig. 3. Chips from the parting off blade.



Photo, Fig. 7 Rear tool post mount, left side.

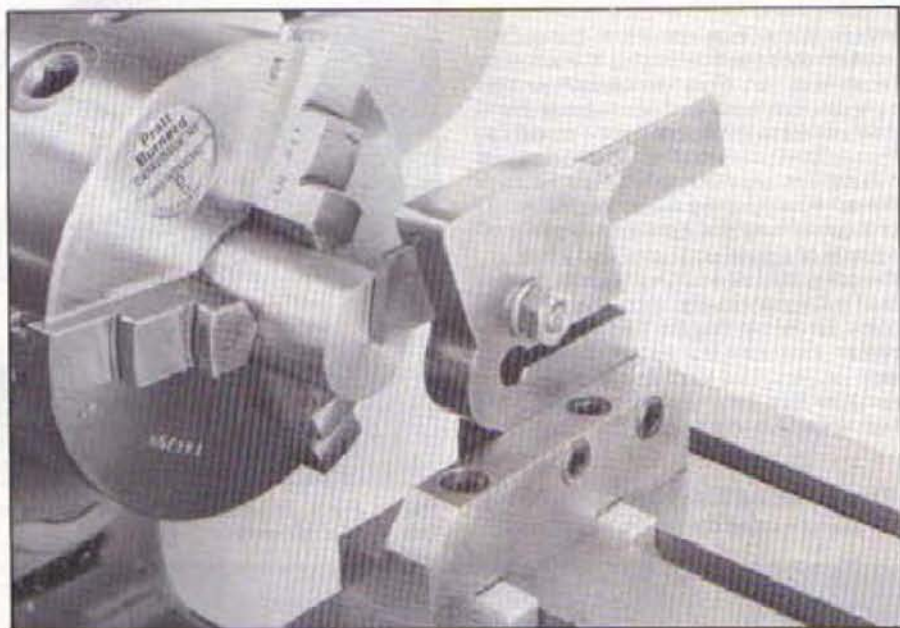
of the metal being removed. Not only does the chip increase in thickness, it also increases in width which presses against the sides of the slot and creates a great deal of friction. With this tightly compacted chip covering the blade tip it is very difficult to properly lubricate the blade with cutting fluid. The result is that a much lighter cut must be taken to get a smooth flow of chips out of the slot. This problem can be reduced by grinding the cutting blade in a special manner.

Many machinists grind a chip-breaking notch on top of the blade adjacent to the cutting tip. This provides a noticeable improvement as it moves the metal away from the cutting tip and creates less packing of the chip in the slot. Cutting fluid is also much more effective with this type of blade. The disadvantage of this method is that when the blade is sharpened the vertical height of the cutter is changed. Also the top of the blade is wider than the cutting tip and this creates a problem. After sharpening a few times one must grind past the notch and make a new end on the blade.

A more satisfactory method is to grind the top surface of the cutting blade concave to present a curved end cutting surface rather than a straight surface. See **Photo, Fig. 2**. This curved surface produces a very special chip as the sides of the slot are cut first and then the bottom of the slot follows. This produces a chip that is curved across the slot rather than flat. The chips are formed into small balls, with a diameter less than the width of the slot, and easily roll free from the cutting tool. See **Photo, Fig. 3**. Even when taking heavy cuts there is still space at the cutter tip to provide good penetration of the cutting fluid to the tip of the blade. You will also note that the metal is not compacted, as with a flat cutting tip, and the chips will be much thinner with the same amount of metal being removed.

This concave surface does not need to be extremely accurate. It can be ground with a small abrasive disk mounted on a drill press the proper distance above the drill table. See **Photo, Fig. 4**. With practice, a satisfactory concave surface may be ground by hand holding the blade to the edge of a grinding wheel. Note the $\frac{1}{8}$ in.

round stone, on the drill press table in the **Photo, Fig. 4**, used to touch up the concave surface. The touch up can also be done with a piece of abrasive paper folded over a small piece of hardened round stock. The edges of the concave surface should be narrow but not sharp and a small section of the original flat surface is left in place. After the concave section is polished, the cutting end of the blade should be ground. This will leave a sharp cutting edge on the concave area. When resharpening



Photo, Fig. 8 Rear tool post mount, right side.

the cutter, hone the concave area first and then remove a few thousandths of an inch from the end in the usual manner.

A properly ground blade will almost double the thickness of metal that can be removed, less heat is generated and the finished cut will be smoother. Grinding the cutter in this manner will not eliminate the need for proper positioning of the tool or the need for extreme rigidity in the whole set-up. In my shop, a Myford Super-7 equipped with a parting off tool with this type blade will part 1 in. dia. stainless steel in about half the time required with a conventional blade in the same tool holder.

Selecting the proper tools

Parting off blade holders can be divided into two general classes, rigid and spring type. See **Photo, Fig. 5**. The rigid tool on the right side is a good quality forged steel tool. The blade in the tool on the left is made from a broken slitting saw blade. The heavy load involved in parting off metal requires extremely well designed tool holders. Uncontrolled movement of the tool between the tool tip and the lathe bed will cause chattering. The tool holder should be mounted with the cutting tip as close as possible to the centre of the top slide mount.

A spring type blade holder permits a slight amount of bend under pressure. See **Photo, Fig. 5** centre. The parting off blade is set on lathe vertical centre and when pressure is applied to the feed on the blade it bends away from the work, which reduces the thickness of the chip. In practice, the feed of the tool is less critical than with a rigid tool and the chip will maintain the same thickness over a wide range of feed pressures on the blade. This regulating action makes it difficult to feed the blade too fast and it is a simple matter to maintain maximum cutting efficiency. Spring type blade holders are not limited to parting off tools but are equally superior for turning and threading tools.

Rigid and spring type blade holders are used on the top slide and on rear tool post mounts. Top slide mounted parting off tools cut with the lathe turning in the normal direction. See **Photo, Fig. 6**. Rear tool post mounted parting off tools must cut in the normal turning direction when the work is

held in a chuck threaded on the headstock spindle. See **Photos, Figs. 7 and 8**. This set-up tends to lift the cross slide and carriage. Special care must be observed in having the slides properly adjusted when using rear mounted tools or chattering will result. When using collets to hold the work, the rear parting off tool may be designed to cut in the forward or reverse direction.

For best results, all parting off blades should be mounted with the cutting tip side of the blade on vertical centre height, parallel to the top surface of the lathe bed. Brass shims may be epoxied to the bottom surface of tool holders to bring the cutting

A rear tool post mounted tool normally makes a cut directly over the cross slide. Tests in my shop indicate that a well designed top slide tool is just as effective if used in a similar position over the cross slide. Both spring type tools used in the tests are shown in place in **Photo 6**. If the top slide tool is extended over the edge of the cross slide toward the headstock, the efficiency is reduced proportionally.

The **Drawing Fig. 9**, is a detailed drawing of the rear mounted spring type parting off blade holder, shown in **Photos, Figs. 7 and 8**, that was designed for a Myford Super-7 lathe. The blade holding section of the tool is made from $\frac{1}{2} \times 2$ in. flat ground stock, and the 20 deg. back side of the tool is the original surface. Be certain that the finished holder will position the blade cutting tip at lathe vertical centre or slightly below centre. The base can be shimmed with brass shim stock to bring it to lathe centre.

The $\frac{1}{2}$ in. dia. hole at the spring centre will provide a rather stiff tool that has controlled spring action with the blade extended up to at least two inches. As I use this tool for heavy cuts, this has been very satisfactory for my use. If your use is with smaller stock, you might want to increase the size of the hole slightly to provide more spring action with lighter cuts.

The recess for the cutting blade should be milled for a snug fit of blades available in your area. The angle ground on the narrow edge of the blade is usually about 15 deg. but check your blades because this angle varies. This 15 deg. cut can be milled with a single point fly cutter made from $\frac{1}{2}$ or $\frac{3}{4}$ in. drill rod. The thickness of the blade will also determine the shape of the recess.

The sharp corners of the blade holder were filed to a pleasing contour and polished before hardening. Make certain that everything fits properly before hardening and check for proper vertical centring after hardening as slight positioning corrections may be necessary.

A parting off blade with this concave cutting surface, mounted in a well designed holder, properly positioned and lubricated, will part metal very efficiently. There is less effort against the top of the blade and less heat will be produced. Because of this, a thinner blade may be used as compared with a parting off blade with the usual flat top cutting surface. A $\frac{3}{8}$ in. blade will easily replace an $\frac{1}{2}$ in. blade with a conventionally ground cutting tip. With a spring tool holder it is unusual to break or damage a cutting blade. As the thinner blade removes less metal and the concave top surface will remove more metal without binding in the slot, parting becomes faster and there is less stress on the lathe. It might take a few attempts to get the top surface properly ground but watch the chips and you can determine when it is correct. A deeper concave surface will produce a more spherical chip and a shallower concave surface will produce a longer and thinner chip roll. When the top surface is correct the chip balls will clear the slot and roll free from the cutting blade. Your lathe will appreciate the lighter load and you will enjoy seeing those chips roll off the parting off blade. GOOD LUCK!!!



PARTING OFF BLADE HOLDER, REAR MOUNTED, SPRING TYPE

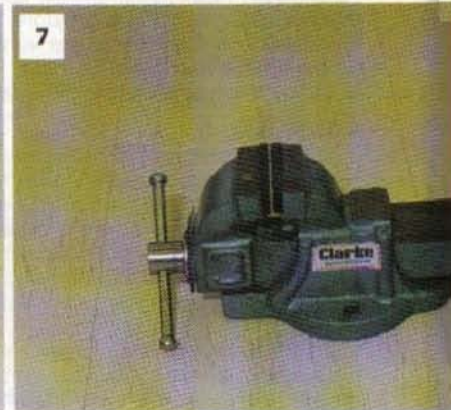
From Malcolm Woodward of Microflame Ltd: A good way of avoiding unsightly work is to adopt the silversmith's practice of cutting off a small piece of rod and laying this in place on the work before heating the flux as opposed to working with a whole rod or stick of alloy.

If the flame is kept a little back from the work until the flux bubbles and glazes over, this will hold the 'pellet' of solder in place when the flame is moved in closer to heat the metal to the point at which the alloy will flow.

Alloy can also be bent into a ring around the tube, but even this may result in an excess melt unless the rod is very fine gauge. Another good dodge is to apply the flame to the side of the work opposite to the solder. Because alloy flows towards the heat, it will then be drawn right into the joint.

A VISIT TO MACHINE MART

One of the largest suppliers of workshop equipment of all sorts, Machine Mart is well known in the industry. A visit was made to one of their premises to see just what the extent of their products was, and it proved to be even larger than expected! They cater for the motor industry, woodworking, and engineering, but also for the home workshop enthusiast. Here we detail just a few from the vast range of equipment available...



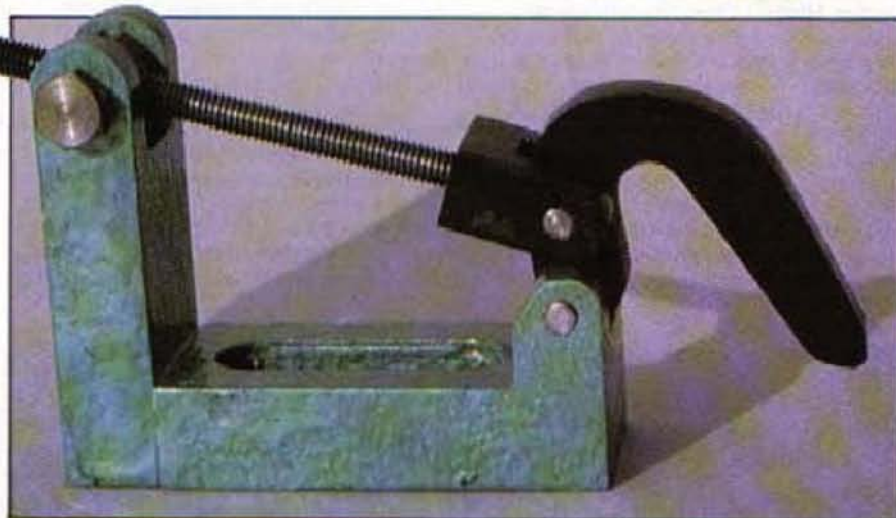
This simply made type of clamp is easy to use and easy to make. Various forms of it have been used for years in engineering firms and it is particularly favoured in tool rooms and design departments. All sizes may be adjusted to suit readers' own particular needs.

FINGER CLAMP

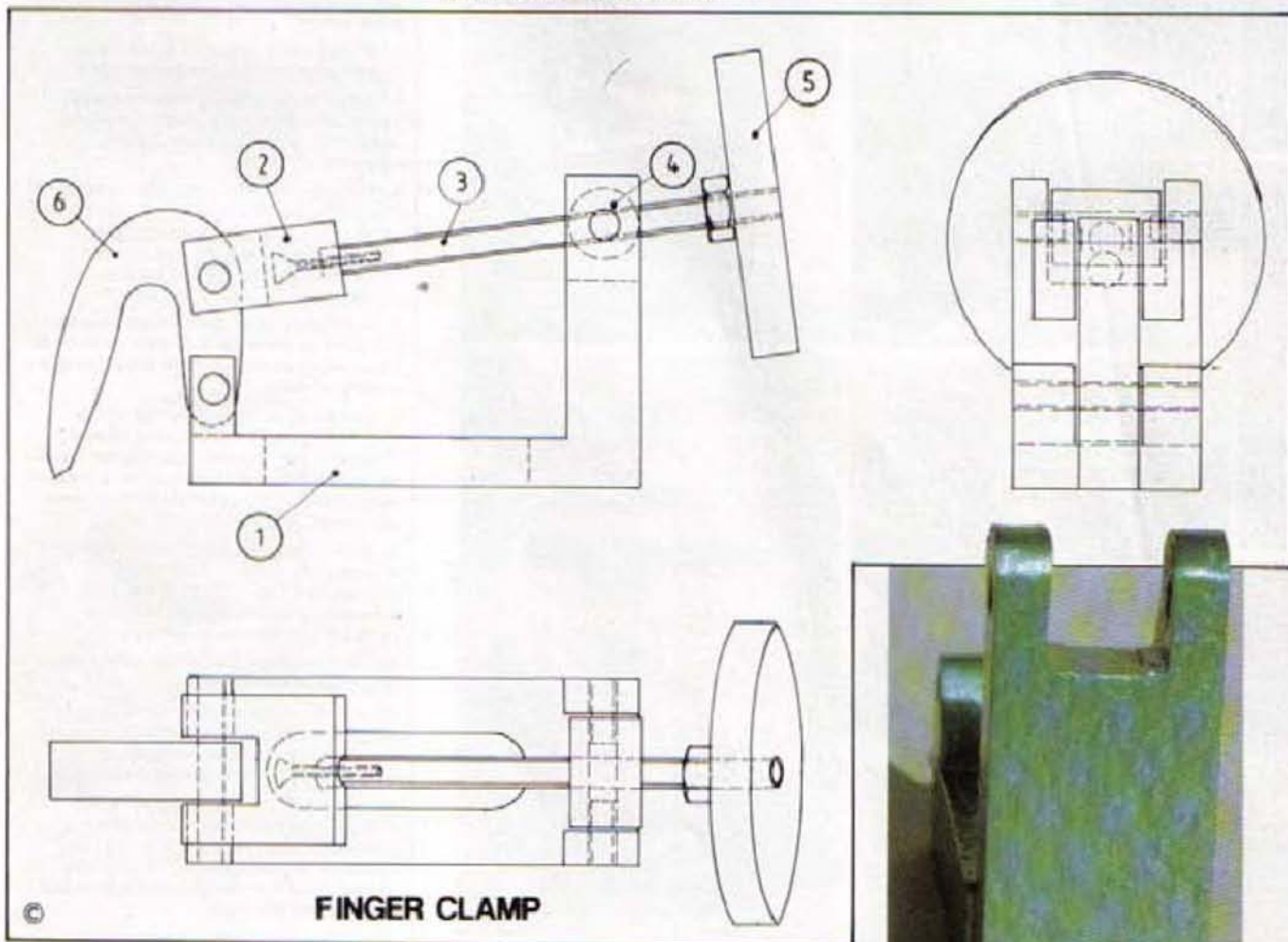
This is a useful little device referred to as a finger clamp because of the shape of the clamping piece which looks somewhat like a crooked finger. In use it will, (if made to the sizes quoted), clamp work from zero to 1in. or 25mm deep. Larger or smaller sizes can easily be made by scaling the dimensions. There is no need to stick strictly to these dimensions and the versions shown in the photographs were made from odds and ends.

The body

The body can be made from a piece of flat bar. Start by marking out and drilling the cross holes for the pivot pin. After this remove the metal to form the flat section and cut the groove. Although, ideally, these operations should be carried out on a milling machine or vertical slide, there is no need to so do, they can be sawn and filed to shape. The groove for the bolt can also

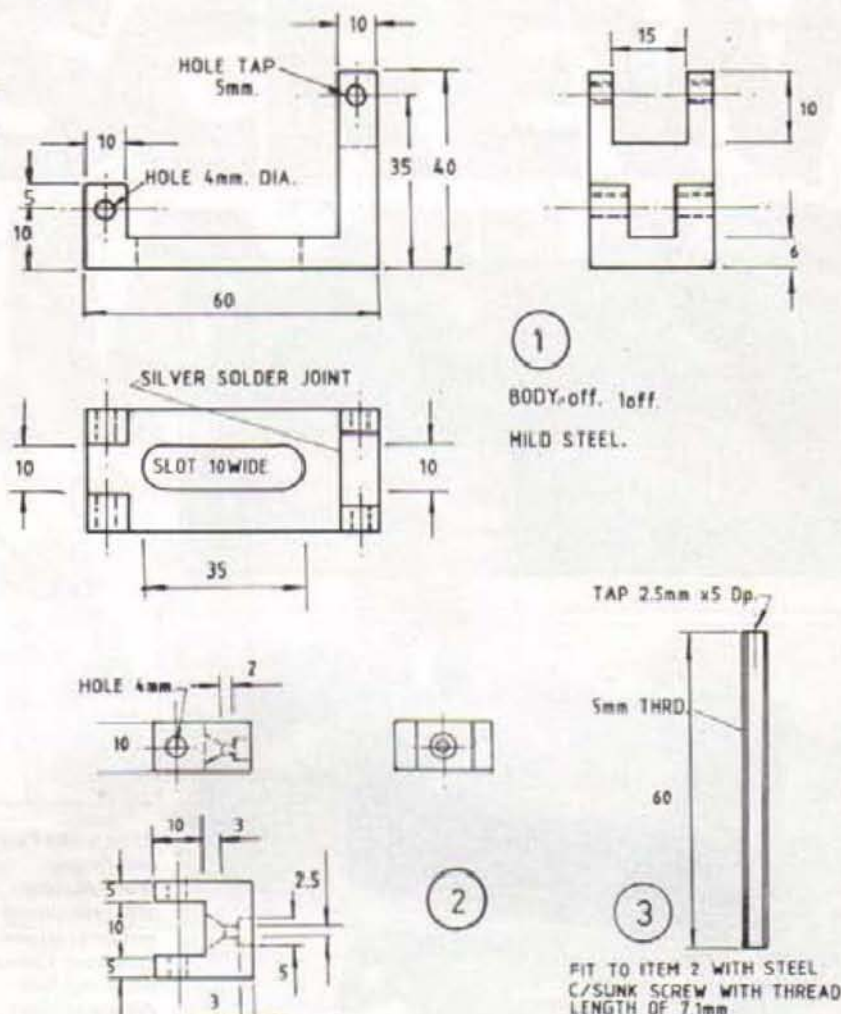
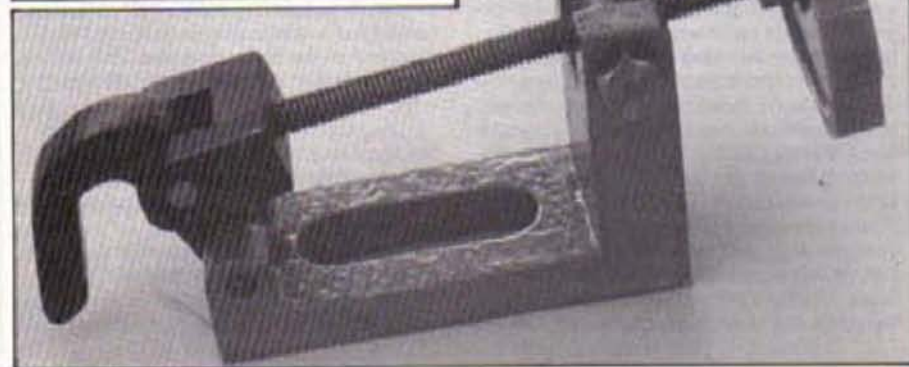
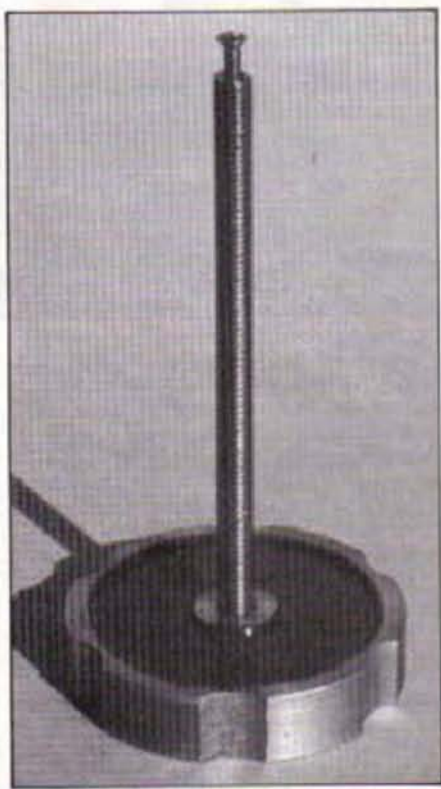


Above, a finished clamp, this one featuring a knurled handle. Below, an end view of the clamp with the bolt-on end piece; doing this means leaving a thicker base to allow room for the screws.





Above, the main body of the clamp after silver soldering together. Below, the handle and screw showing the fitting for the fork.



be milled, but if one so wishes this can be just left as a clearance-sized hole for whatever bolt is to be used.

The end of the body is also made from flat bar. First of all, cross drill and this time tap as well, for the pivot holes, then mill or saw and file the gap for the pivot. When it is done, clean it up and silver-solder the

Finished item, this time with a shaped handle.

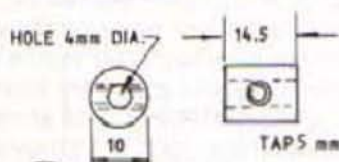
two parts together. If silver-soldering is not in your line, then not to worry. Make the flat part of the body a little thicker and fit the end piece with screws. It will almost certainly mean that the whole clamp will be higher and the front portion will also need raising, but this will not affect the final operation of the tool at all.

The fork

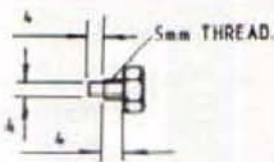
The fork, like the other parts so far, is made from flat bar. Black mild steel was used, but bright will do just as well. It is important that the ends are square, and so they should be turned in the four-jaw chuck. The hole for the pivot pin should also be drilled in the four-jaw chuck to ensure it is square across the fork. The actual fork can be cut out either by milling or filing. The work is then returned to the lathe and the hole to take the screwed adjuster rod is drilled. This is clearance size for the rod used, and goes to a depth of about 4mm. It is continued right through clearance size for the screw to be used. Although shown as metric, 8 BA will do for that. The fork can be placed in the drilling vice and countersunk for the screw head.

Adjusting rod

The screwed adjusting rod can either be a piece of commercial studding or made up from bar stock. Apart from the end that is drilled and tapped it is a plain threaded rod. The depth of the internal tapping must depend on the length of the screw to be used. That is about the only critical

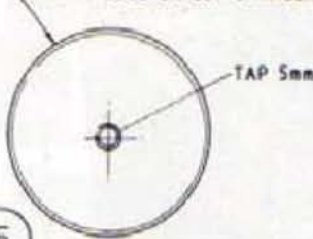


④ PIVOT 1off. MILD STEEL

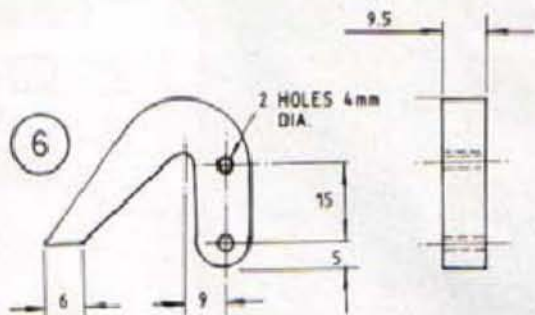
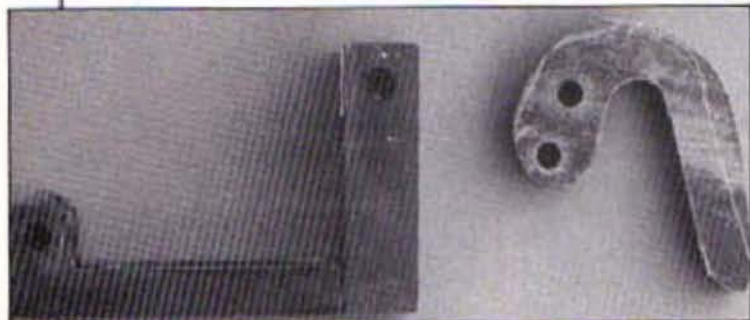


PIVOT BOLT.
2off. M/ST.

KNURL EDGE OR CUT 6 FINGER GROOVES FOR GRIP.

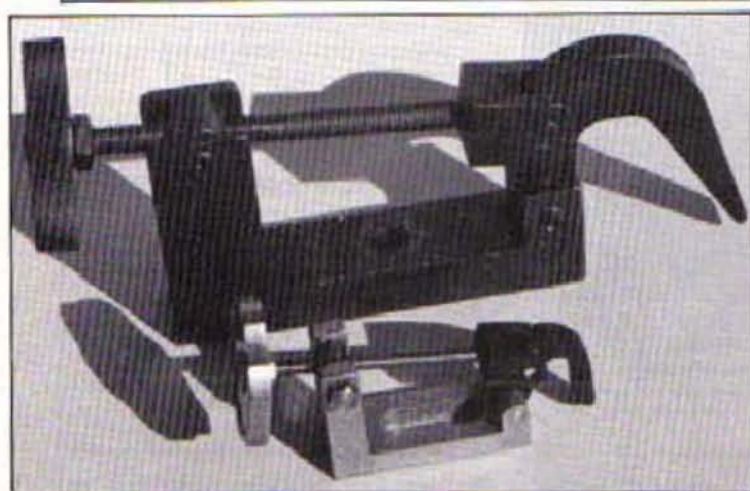


⑤ HANDLE 1off. MILD STEEL.



CLAMP 1off. MILD STEEL.

TWO 4mm DIA. M/STEEL PINS REQUIRED
TO ATTACH TO BODY.



At top, the body and finger immediately after roughing out operations. Left, two clamps showing how different sizes can be made to suit individual requirements.

one. As long as the scribed lines go right across the face, the six divisions will be equal. The handle was then attached with a half round file to form finger grips, as can be seen on the photographs.

If you want it a bit on the fancy side, a recess can be turned in it on each side, but this of course has no effect whatever on the function of the tool. Upon final assembly the wheel is locked to the adjuster screw with an ordinary nut.

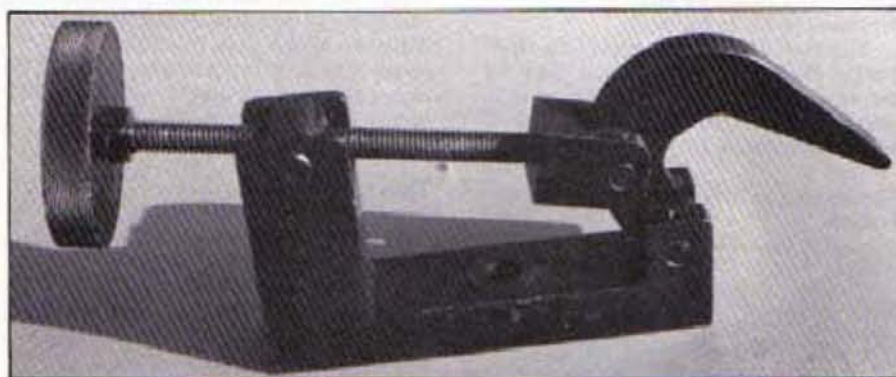
The finger

The finger itself is carved from a piece of mild steel. Readers wanting something a little more elaborate could make up a double one with two prongs or could make one from hard plastic to prevent it marking soft material. The two pivot holes should be drilled before cutting the shape out. This allows one to ensure that there is enough metal left round the holes when cutting to shape. The actual shape is not too important, as long as it roughly resembles the one shown it will do the job.

All that is required now is two pivot pins for the finger. These can be a push fit. The best way to do this is to cut the rod to suitable lengths and just knurl a short piece. Push it through from the plain end and when the knurl reaches the hole it is pressed in, when it will bite and hold secure. If no knurling tool is available, simply put a centre punch mark on the diameter of the pin at one end. This will raise the metal sufficiently for it to bite when driven home.

The pins for the pivot are shown with hexagon heads, but this is not absolutely necessary. As long as they will screw into the body and fit the hole in the pivot that is all that matters.

There it is, an easy to use clamp, made from odds and ends, and it is worth considering making a few more when metal and time becomes available.



Another study of the finished, knurled handle clamp.

measurement. When the fork is placed on the screwed rod, the screw must tighten down and bottom out in the rod leaving it free to rotate in the fork with as little shake as possible.

The pivot is a piece of mild steel or brass and is simply turned to fit in the cut out in the end of the body. It is drilled through clearance size for the pivot pin, and then cross drilled and tapped for the screwed adjuster.

Hand wheel

The hand wheel was made from mild steel but again brass, aluminium, or plastic

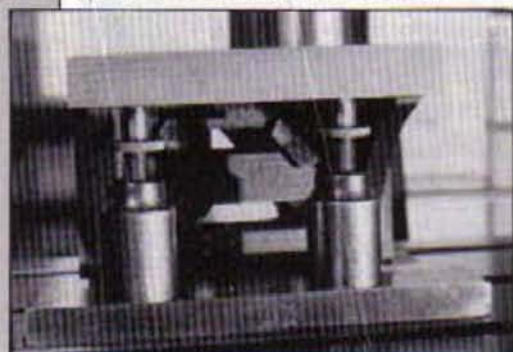
would work just as well. It is simply drilled and tapped in the lathe to fit the adjuster rod. The edge can be knurled to enable a better grip to be obtained. In the case of the one shown, there was no knurling tool available to do this. The metal was marked into six sections, by simply holding it in the three-jaw chuck. One jaw was located on a piece of bar on the bed so that the centre of the jaw was in line with the centre height of the lathe, and a line was scribed with a sharp tool set on centre height across the face of the workpiece. The chuck was moved to the next jaw and the action repeated and then the same with the third

This is one of those little projects for a few odd moments, the end result being something which will be forever useful in the workshop. We cannot have too many screw jacks, particularly with a range of sizes. They can be used for milling, turning, and marking out operations, all with equal suitability

These are, most useful accessory to have in the home workshop, and yet rarely do people seem to bother to make them. Not that there is any real bother involved. They are a good exercise for the beginner, and at the same time the sort of little job that the more experienced machinist can do in the odd spare moment. They have another advantage – they can be made from those little short ends of bar stock which we always save because they will come in useful, and which twenty or so years later we still have in case they do come in useful!

Materials

The jacks can be made from any diameter material from around $\frac{1}{4}$ in. dia. upwards. Small ones of that sort of size



Screw jacks have been used here (above), first to level a casting and then to support it during milling operations. Far right, typical method of making a screw jack.

SCREW JACKS



A set of small, home-made screw jacks photographed here together with some additional height pieces.

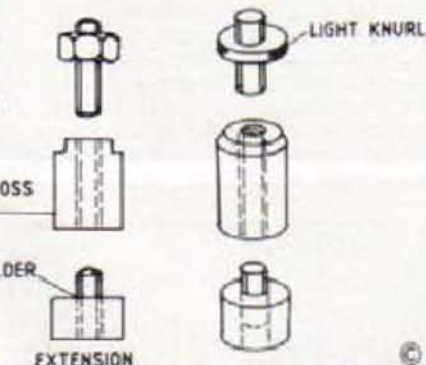
SIMPLE SCREW JACK.

ALTERNATIVE JACK.

BODY DIA. APPROXIMATELY THE SAME SIZE AS THE NUT, ACROSS CORNERS.

SILVER SOLDER

EXTENSION



prove to be very useful at times but so can those of heavier construction. The aim, therefore, should be to make as many different sizes as there are materials available. Although the use of odds and ends is ideal, there are cases where it is handy to have two jacks of the same size and this should be borne in mind if a suitable piece of steel comes to hand. The jacks can be made from ordinary free-cutting mild steel, but other materials will also serve.

Construction

To make them, simply take a piece of bar of whatever dia. is around, and face both ends to get them square. Remember to remove the burrs, particularly when changing the metal round in the chuck, or they might not end up as square as one would wish. Once this is done, drill right through and tap. The size of thread should

be roughly in proportion to the size of bar used, but as the bar gets thicker the ratio of thread to bar can get smaller. For example, the small jacks pictured here are $\frac{1}{4}$ in. dia. with a $\frac{1}{4}$ in. thread. The larger ones seen in the magazine are of 1 in. dia. material with a $\frac{1}{2}$ in. thread. This will give readers a rough idea of the proportions.

The moving part is a piece of threaded rod; it has a nut on it and this can be either hexagon or it can be round and knurled. The advantage of the hexagon comes when the jacks are used to support work and some pressure is needed; where they are used simply as packing, the shape is of little consequence. The threaded part can either be machined as whole, or a piece of commercial studding can be used, with the nut either brazed in place or secured with a strong retaining compound such as Loctite 601. The end of the threaded rod, which will act as a support, should be square.

Extensions

That really is all there is to it. However, handy extensions can be made by threading pieces of bar, which have squared-off ends, so that one end will accept a thread and the other has one standing proud. If extra height is required, these can be threaded into the bottom of the jack and raise it to what is needed. Once again, the piece can either be turned down and threaded or it can be drilled and tapped and commercial studding used. The threaded part must hold firm in the body, otherwise it matters little how they are made.

There we are then, a quick little job to help you in getting out of the washing up, or that must be done when those dreaded in-laws appear.

The only thing to remember is: do keep your jacks in a box. They have minds of their own and hide themselves all over the workshop if they are not taught better.

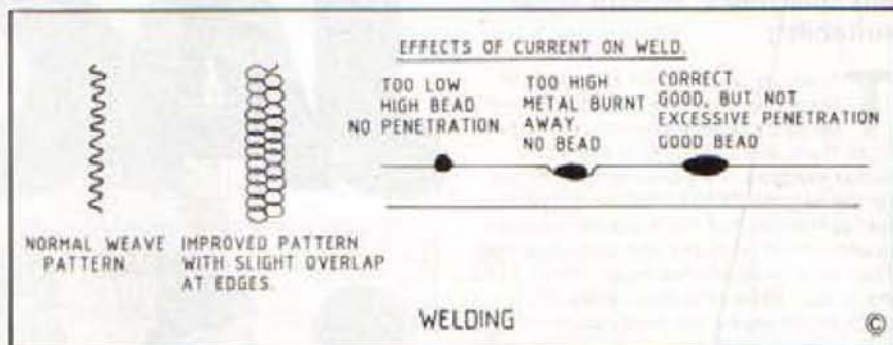
Arc welding is something that needs a great deal of practice to become even moderately efficient in; such skill cannot be passed on merely by writing about it. The types of joint construction and details of equipment are another matter and perhaps some of these facts will be passed to readers through this article

Welding is a process of joining metals by softening the edges and then fusing them together. Many years ago it was always a source of wonderment to watch the local blacksmith mending farming equipment by welding. There was none of the sophistication that we know today; both pieces were put in the furnace until they were almost white hot and then hammered together, sometimes with a form of lap joint. On other occasions the two pieces were simply hammered together. Of course, it took many heatings and required a great deal of skill, something that was rarely appreciated...

There are now many forms of welding used for different purposes, but it is proposed here to deal purely with electric arc welding. The reasons are simple. Firstly, a number of the projects in the magazine have called for welding. Whilst this does not necessarily mean arc welding, that certainly would be the quickest method. Then there is the fact that electric welders have, over the years, dropped in price to a level where a large number of home enthusiasts can now afford them. The third and most important reason is that a number of readers have written to say that they have bought small welding sets but cannot get the best from them.

It is not possible for a mere magazine (even though it is M.E.W!) to pass on welding skills. A good welder earns a great deal of money because acquiring such skill is not easy and top people are not easy to

ELECTRIC ARC WELDING



find. We can offer some hints and tips on the best way to go about things but, when it comes down to it, the final result will only come with continual practice, and self-criticism.

The equipment

Whilst for industrial purposes there is a choice of many types of electric welder, for the average person in their home workshop the choice is narrowed to about three types – partly because a welder is needed that can be plugged directly into the normal thirteen amp socket. There are M.I.G. welders these days, very fine pieces of equipment, but comparatively expensive. These will do a very good job, and they actually weld the metal through a film of gas, a process which has many advantages. We will be dealing with their use in detail at a later stage. In this issue we are concerned with pure arc welding and so two choices of equipment are left. The oil-cooled set or the air-cooled set.

Oil cooled welders

The main advantage of an oil-cooled welder is that it can be used for continuous welding operations over a long period. The disadvantages are that they are the more expensive type, and they are invariably more bulky and much heavier. This is rather inconvenient unless the operator has a very large workshop where the equipment can have a corner allocated to it.

Air-cooled welders

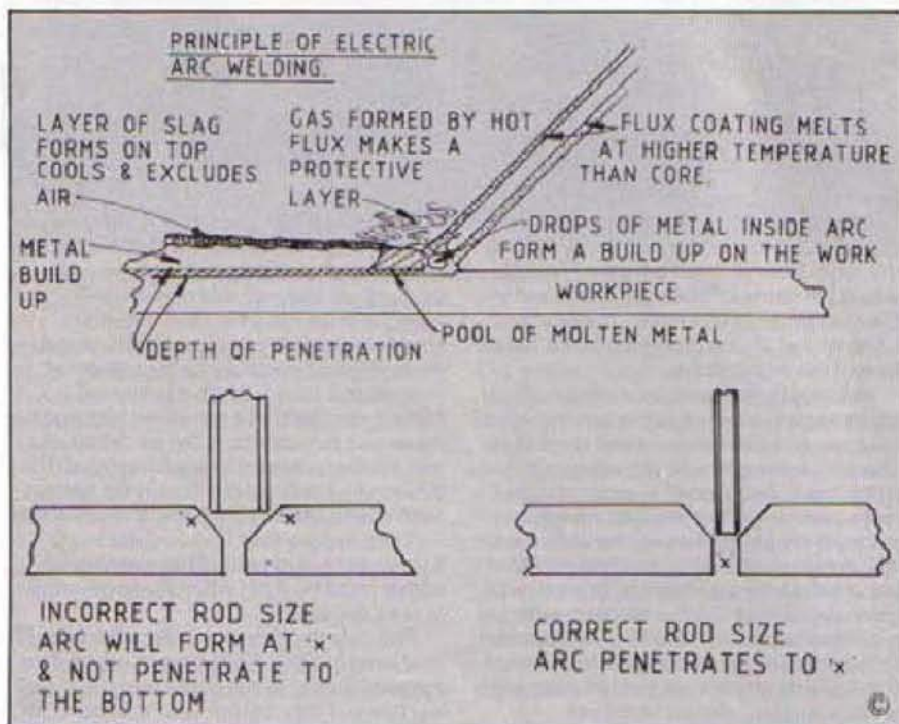
For competitive price and for size of equipment the air-cooled welding set will come into its own. Most have thermal cut-outs to prevent welding being carried on for too long a period and so ruining the transformer. As a rule, the time allocated before the set cuts-out is ample for home workshop usage. Prices obviously vary according to quality and often also govern the power available; it is as well to get a set with as much power as practical within the limits of one's pocket.

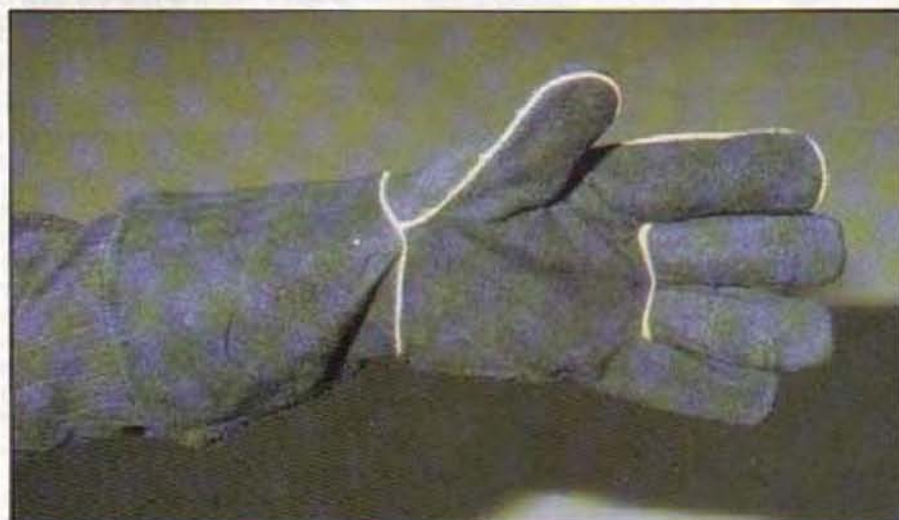
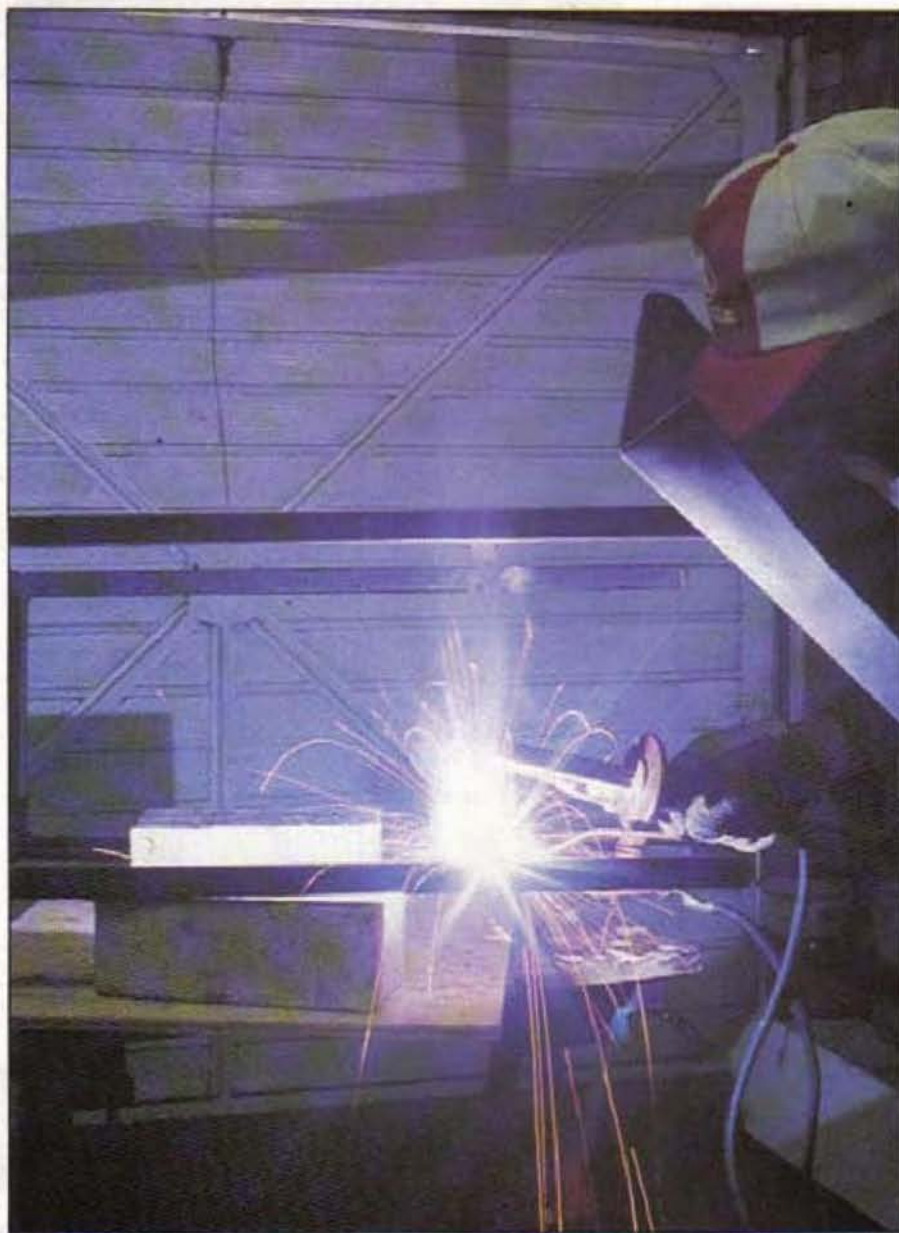
Electrodes

Arc welders work as a result of the heat created via an electric arc. To make this arc, an electrode – more commonly known as the welding rod – is used. This is a steel rod coated with a flux. As the arc is in progress, the rod melts away and so gets continually shorter. The question of the correct electrode or rod to use is not an easy one to answer. There are very many varieties, mainly designed for different purposes and so the manufacturer's instructions must be used as a guide as to whether or not that type of electrode is suitable for the job in hand. They also come in different sizes. Most home welders will need one of the smaller diameter rods. Current rating of the transformer (all have a range of settings) will depend on the diameter of the rod used as well as the thickness of the metal to be worked on. Here again, practice is the important thing but a rough guide is to use one amp of current for every one thousandth of an inch thickness of welding rod.

Safety

Safety in welding is, like all other engineering practices, of the highest





Good stout gloves should always be worn; if possible, the gauntlet type such as these from Machine Mart which retail at under £5 a pair.

importance. There is a particular danger in this case from the arc itself. The eyes must be protected with a properly made piece of glass at all times. When the arc is in operation, both ultraviolet and infra-red rays are created and these can cause very nasty skin burns. In particular, they can

affect the eyes, there being a particularly painful effect known as 'arc eyes'.

Different grades of protective glass are designed for different current ranges in use and it is better to use a heavier one than necessary. The use of a lighter type than that recommended can result in permanent

eye damage. If a welding set is purchased new then, as a rule, the manufacturer supplies a hood or shield with the correct glass already fitted. The glass can be either in a hood or a face shield. The hood is better, as it gives greater protection but some welders find they can use a shield better than the hood and prefer it that way.

Never be tempted to use sun-glasses or even glasses designed for gas welding purposes for arc welding; the arc can cause permanent eye damage.

Other vulnerable parts of the body should also be protected; arms should be covered and necks also covered by a heavy overall or coat. Gloves should always be worn to protect the hands from burns. It

Below, face protection is essential. Bottom, a typical arc welding set; relatively cheap to buy, they are the sort of equipment that will prove useful over a long period.

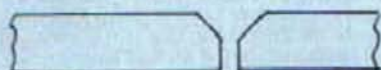


hardly needs saying that slippers, sandals, etc., should *not* be worn. Remember that hot pieces of metal fly off the work when welding, and you must be protected. Welding sets should be switched off as soon as work is finished – you are dealing with heavy and dangerous electric currents, and whilst there is no danger under normal circumstances, it is silly to get careless.

The arc

The arc is created by striking the electrode on the work and quickly removing it to a suitable distance where the arcing effect will continue. This, for the beginner, is far from easy and the electrode will tend to stick. If this happens, the set must be switched off at once if a quick sideways jerk does not immediately free it. A cold electrode is always difficult to strike

A GAP OF ABOUT 1/16" SHOULD ALWAYS BE LEFT BETWEEN PLATES BEING WELDED ON MATERIAL THICKER THAN 3mm.



GRIND OR FILE A 'VEE' AS SHOWN.



THE SECOND RUN FILLS HALF TO TWO THIRDS OF THE VEE

THE FIRST RUN SHOULD FILL THE LOWER GAP & PENETRATE THE METAL



THE THIRD RUN CROWNS THE JOINT.

with, and a good tip is to clamp an additional plate of metal to the job. Make a couple of strikes on that to warm the electrode and then start on the actual work. The arc will be much easier to strike and maintain in position. Anyway, the practice strikes on the spare metal plate enable one to get the feel of things, and it is much better than trying to start straight away directly on the work.

Direction of weld

Always arrange the work so that it lies flat whilst being welded. Trying to work up and down is nearly impossible, and every effort should always be made to work on a horizontal plane. It is normal to weave from side to side when welding in order to get better coverage; this weaving effect must not be exaggerated and should only cover the equivalent of the rod diameter on each



side of the straight seam being welded (total three times the rod diameter). If it is necessary to take a second run over the top, ensure that all deposited slag is first chipped away.

Coverage

All seam joints when possible, should be welded on both sides. Plates should never be butted directly up to each other but a small gap left to allow the pool of molten metal that is formed to run in and fill it. Any metal over 3mm thick should have a small vee along the seam to allow penetration of the welding material to take place.

In the case of angled joints, fillets should be built up along the edges of the metal. Again, a slight gap should be left between the metal to allow the weld to flow into position. Seams should be made along both edges.

Where two different thickness metals are to be joined, it is an advantage to reduce the thicker one at the point of the weld to a thickness similar to the thinner material. If lap joints are made, then an undercut on one or both of the materials will allow better penetration.

Cast iron

Special electrodes are available for welding cast iron and these can be used for building up broken castings, etc. Care must be taken in the selection of electrodes as some leave a deposit that is difficult to machine. Almost inevitably, there will be some distortion when welding cast iron as there is with all welding operations.

Bronze welding

Bronze welding rods can be used for welding together dissimilar metals as well as bronze, etc. They are comparatively easy to use but might not be easily available. Stainless steel is difficult to weld without a M.I.G. welder but it may be possible to use a bronze rod on small stainless steel welds.

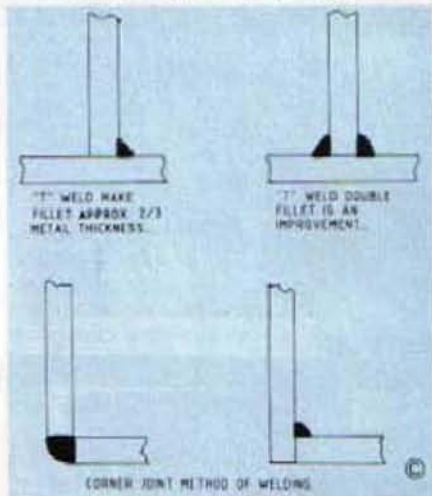
Conclusion

As stated at the beginning of this article,

successful welding will depend almost entirely on practice.

Try as we may we cannot give any more than a brief account of the process in this short article. However, there is a video on the subject, entitled *Manual Metal Arc (Stick) Welding Mild Steel with Low Power sets*. Made with the less experienced in mind, by the Welding Institute, it gives instruction on the best way to use the process. For readers who would like to pursue this fascinating part of the hobby, we have arranged for the video to be available through our Readers' Services Dept. at a cost of £24.99 including VAT and p&p. Send your order to Readers' Offers, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST, quoting RO/ME/41. The credit card hotline is available on 0442 66551.

It is recommended that plenty of



practice is done on scrap material before attempting the more important jobs. Under no circumstances should the unskilled welder try making boilers; this is a job for the expert. Only a qualified coded welder should be entrusted with such work and, in all probability, an insurance company would not accept a boiler for insurance purposes unless it had been made by such a person. This apart, small home welders can be very useful for the home workshop and enlarge the scope of workshop activities considerably.



Above left, a typical example of a good quality weld where the electrode has made a single pass. Above, a typical weld with three passes of the electrode.

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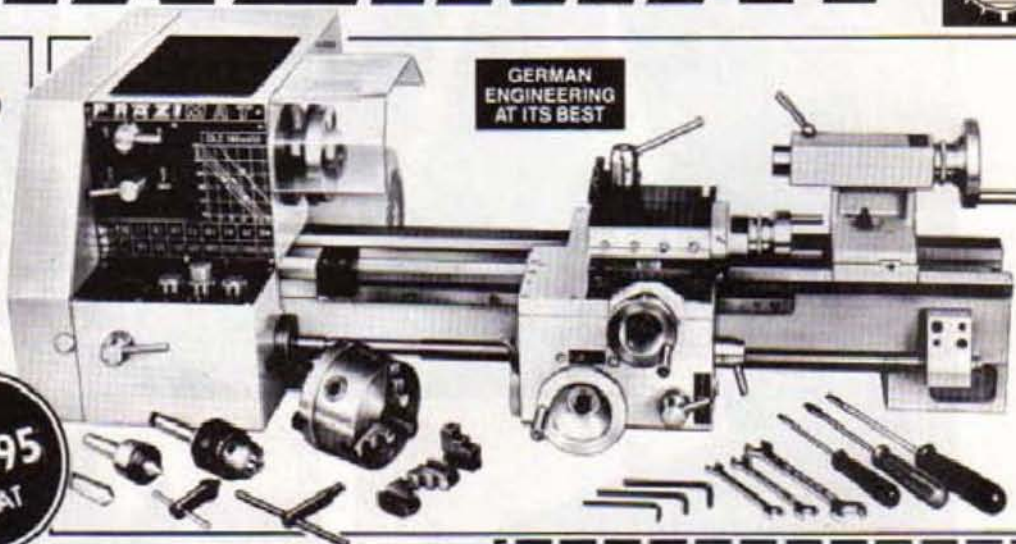
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A HOME MADE BELT SANDER

A belt sander can take much of the hard work out of shaping metal; it is also easier to work to precise measurements when using one. In this well detailed article, 'Bluey' describes how he set about it, as usual using the cheapest possible methods. The result is a very robust piece of machinery, capable of heavy-duty work.

Several years ago I was looking at the possibility of making a belt sander. These are often referred to as 'Linishers', but in fact this is a trade name and so should not be used. I had been spurred with the ambition to make the machine because someone had given me a sanding belt! This was a standard size of 36 x 4 ins. and my calculations showed that, to get the best performance with this size of belt, a motor of around half a horsepower would be required. Not having one of this size, but having several ex-washing machine 1/2 horsepower models in the workshop, I decided to cut the belt

lengthways. A 2 in. wide belt is far more practical for model engineering purposes, the wider one being better for woodworking. To reduce the width of the belt, it was turned inside out and cut down the centre with a sharp knife. This, of course, then determined the size the belt sander would be.

The ball races

The sizes of components will, to some extent, depend on the size of these. The

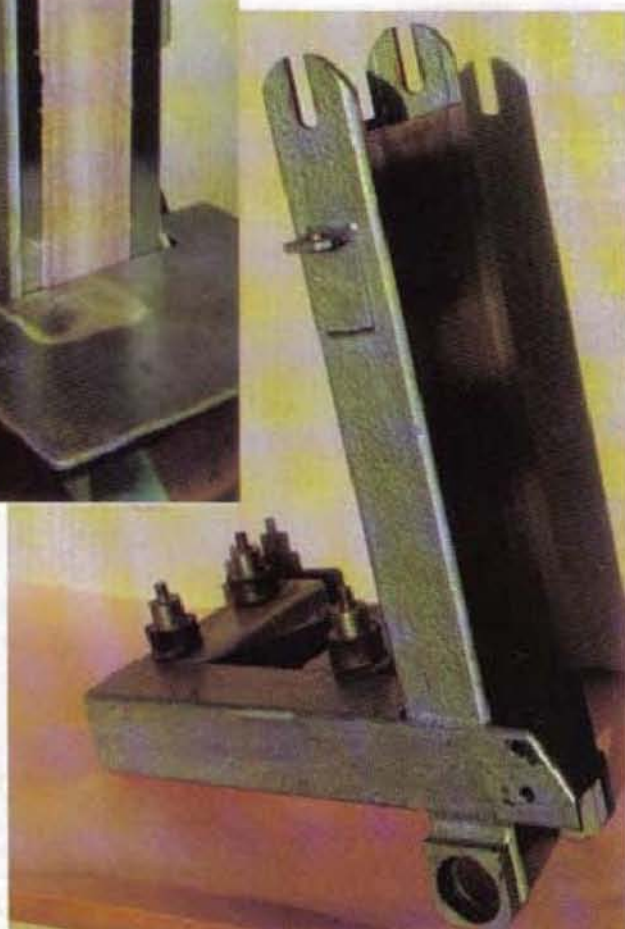
ones used were 35mm outside diameter, 17mm inside diameter, and 10mm wide; they were double-shielded. Unless one wants to buy expensive new ones, then in all probability different sizes will be used. They can be obtained on the surplus market, but it is advisable that they should be double-shielded.

The body

This was constructed from a piece of heavy box tube, 90 x 50 x 5mm. It is not



Below left, the rear of the frame; mounting rubbers for the motor can be seen over the fixing studs. Below right, the frame from the front. At left, the finished sanding machine; it is far more rigid than those normally purchased and costs very little to construct. The belt guard is removed here to show construction.



with the shaft, the size given of 35mm dia. suited the bearings used, but the holes must be made to fit whatever size will be used.

Belt tensioning bracket

This is a comparatively simple cutting and filing operation using 50 x 50 x 3mm black angle iron (guess where from!).

The lock-nuts

It may be possible to use a standard size nut for these but it is better to make proper ones to fit. The ones used were from 24mm across flats, hexagon steel, drilled and tapped $\frac{1}{8}$ in. x 26 threads per inch to give a nice fine adjustment.

Tensioner shaft

This is a pretty straightforward turning operation, from 20mm dia. steel bar to start with, the important dimension again being the one shown as 17mm for the inner diameter of the ball race. Four 5mm slots are milled in it to allow it to be an easy sliding fit in the finisher body. The two 8mm dia. holes are countersunk to accept the belt tensioner.

Idler roller

Made from 2 in. dia. bright mild steel, it is bored 25 mm right through. Each end is counterbored to accept the ball races, the measurements shown for this being 35mm dia. by 10mm deep. The outside diameter was crowned 0.5mm to keep the belt running centrally when in operation. Obviously, some degree of accuracy will be required with this component, and unless the three-jaw chuck is very accurate it will probably be as well to make it in the four-jaw, and true the work up with a dial test indicator. Whilst an error of three or four thousandths of an inch would make little difference, if the work is done in a three-jaw chuck with an error of that sort and turned round for counterboring the other end, unless one is very lucky indeed, the second end will be considerably more out of line.

Belt tensioners

These can be made as per the drawing from $\frac{1}{8}$ in. dia. mild steel, the radius produced with a form tool or by hand. The small hole shown as 1.6mm dia. is to take a



The top roller complete with adjusters; note the slots in the spindle which allow the assembly to slide in the frame.

$\frac{1}{8}$ in. dia. split pin. The stud can be screwed into the end and secured with a drop of Loctite 601. Alternatively, the component can be made in one piece, the thread being machined from the bar.

Mounting frame

Made from 50 x 50 x 4mm box section and cut as shown in the drawing, this was welded together, but no doubt those who do not have welding facilities could devise other means of joining the parts. An alternative is to take it along to your local friendly metal fabricator, and ask him to just touch the welder on it. You could also ask a garage to do it but they would probably charge a lot more.

The table

This is made from 4mm thick black plate, and welded to the tilting bracket which is cut and filled, or milled, from a piece of 50 x 50 x 6mm angle iron. It might be possible to use a thinner angle but the size quoted gives plenty of strength. The bracket and table are welded together, but could possibly be bolted. After welding, check that the table is still flat - arc welding tends to distort material, if it has warped or twisted, hammer it as flat as possible, and as square to the bracket as possible, and finish it off either in the lathe, by mounting it on the cross slide and fly cutting, or in the milling machine.

Assembly

The bearings were welded into the sander body; a spigot can be used to locate the hole centrally. This is shown on the

drawing but some alteration of sizes may be necessary. The tensioning brackets are welded to the side.

The drive shaft is assembled by first fitting the ball race to the threaded end, then passing the shaft through the left-hand bearing housing and through the drive roller, which is positioned between the fork ends. The second ball race is inserted into the right-hand bearing housing and the drive shaft located. The bearing retainer can then be fitted using a 2BA x $\frac{1}{2}$ in. cap head screw, or similar, and a hole drilled into the end of the shaft to accept the locking pin. This is necessary to prevent the bearing retainer from coming loose.

The drive roller is centralised and locked in position with the grub screws. The top roller is assembled by first fitting a ball race to one end of the tensioner shaft, and a second ball race fitted to the opposite end of the idler roller. The roller is slid on the shaft, until both ball races are located. These can be held in place with Loctite 601 or similar retaining compound, or with centre pops at the bearing edges. This swells the metal and prevents movement.

The two belt tensioners are inserted through the tensioner shaft so that the radius locates with the countersink in the shaft. A washer and split pin retain these to the shaft.

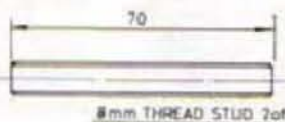
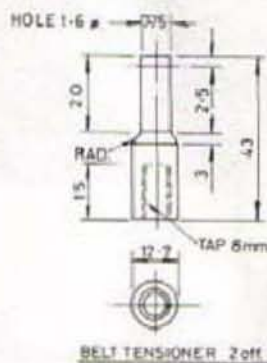
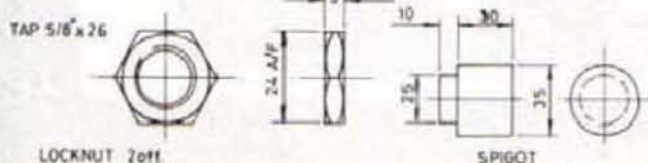
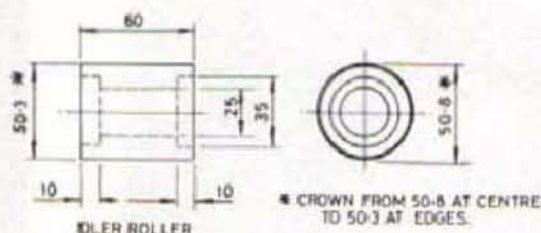
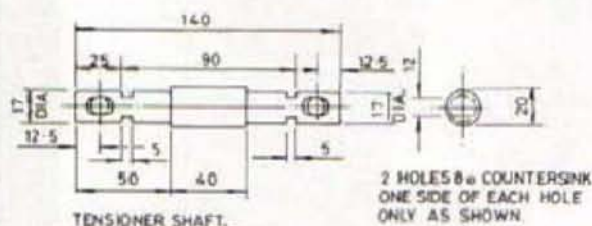
The assembly can now be slid into the fork, locating the two threaded adjusters into the brackets, with lock nuts on each side. The table is fixed to the mounting frame with 8mm bolts and washers, two lock nuts being fitted to the pivoting bolt.

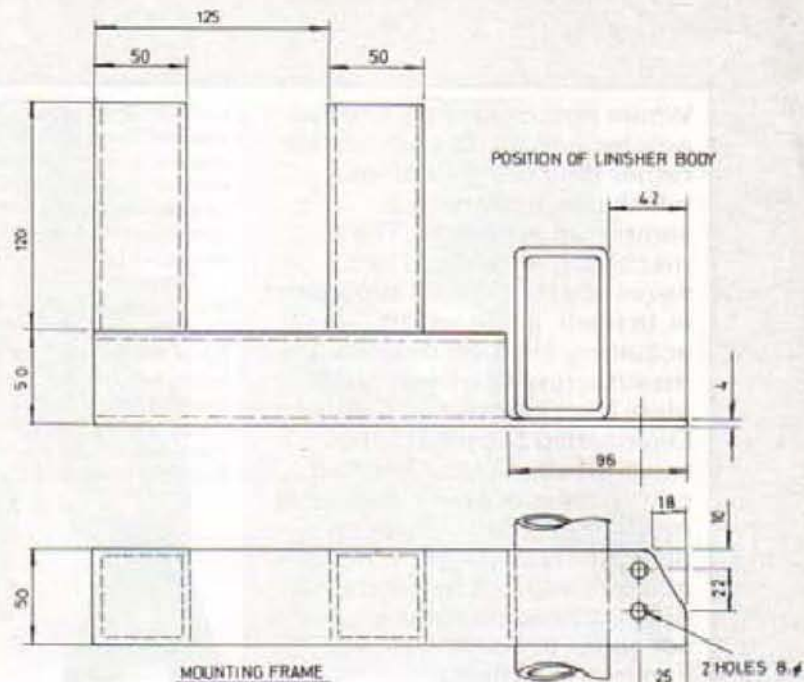
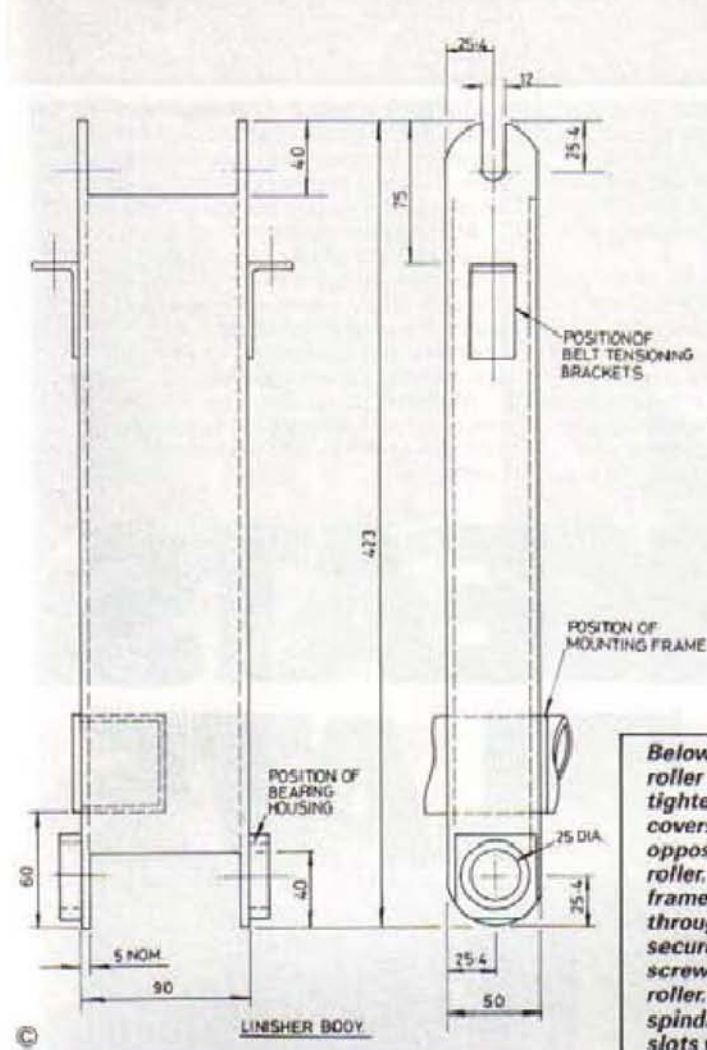
Fitting the motor

Obviously, the fitting of the motor will vary with the type being used by the individual. Since a secondhand, surplus motor will probably be used, it is not possible to describe exactly how the fitting is done but a few points from my own model may be of interest. The motor was mounted on four black rubber mountings, which were ex-motorcar radiator mounts. This meant that the sander ran much quieter than one would normally expect and it also allows a certain amount of twist to the motor so that, in an emergency, the belt will slip.

A vee belt and pulley with a ratio of one and a half to one allowed an increase of speed, which gives satisfactory results. The actual fitting of the belt is not difficult, as the table will allow positioning without any adjustment.

The fitting of the sanding belt is comparatively simple. Many sanders require a certain amount of dismantling to put the belt on but, in this case, the table allows it to slip on without any fiddling





Below, one side of the bottom roller showing the nut tightened up on the bearing covers. Below right, the opposite side of the bottom roller. It is put between the frames, the spindle slid through then the roller is secured with the grub screws. At bottom, the top roller. It can be seen how the spindle fits the frame via the slots which prevent it rotating; the adjusting nuts can also be seen.

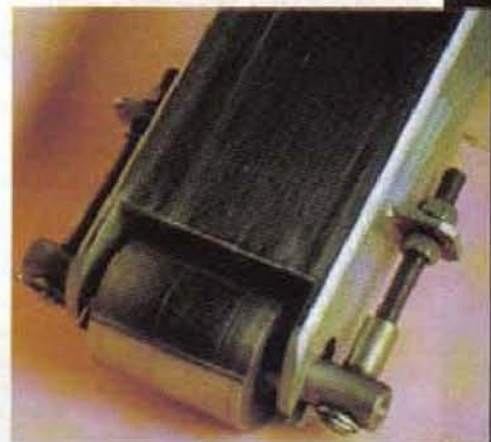
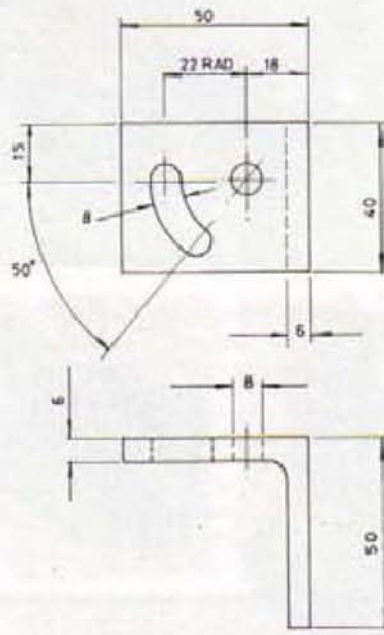
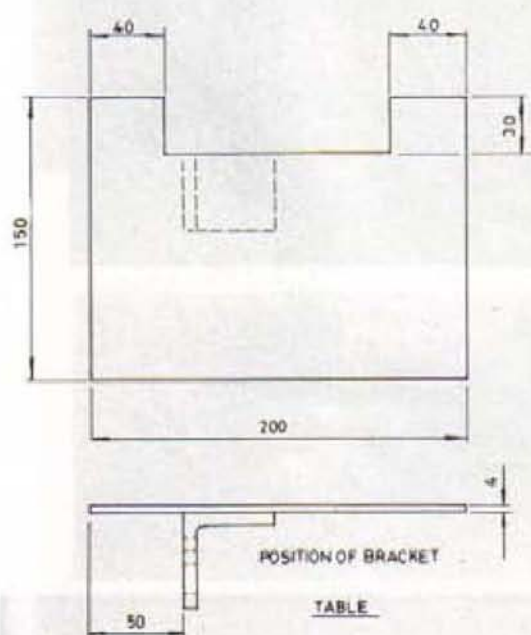
this should be the pushbutton type, but this is not strictly necessary. When using the sanding machine, the eyes should be protected with safety glasses, and it may also be advisable to wear gloves. These not only stop sharp stings on the hands from the grit flying off, but also offer a certain amount of protection from heat. Metal being sanded heats up very quickly indeed and is capable of giving nasty burns if one is not careful.

Well, there it is! A most useful tool – you can now put away most of the files. Using

about. Once on, the tensioners can be adjusted evenly on each side. When this is done, switch on and check for the alignment of the belt; if it runs to the left tighten the right-hand tensioner, or vice versa until it runs true.

Safety precautions

A belt guard should be fabricated from thin sheet and fitted with brackets to the side of the linisher body – this will prevent a sleeve being caught up or some similar accident. A switch should be mounted at a suitable point to enable the machine to be switched off as quickly as possible. Ideally,



various grades of belt which, incidentally, are available in the size 36 × 2in., metal can either be reduced in size quickly or polished to a high finish. Outside radii are easy to shape, and life takes on a whole new meaning in the workshop!



Where possible we try to offer articles that involve fabrication rather than using castings which can, at times, be somewhat expensive. The machining of castings in a sequence that will be successful is, in itself, a skill worth acquiring. Here we describe the manufacture of a Keats angle plate from castings by College Engineering Supply. It is not too difficult, and the finished product is absolutely invaluable for clamping odd shapes, particularly castings, to either a milling table or a faceplate. All drawings and castings are the copyright of College Engineering Supply.

in the milling vice on a parallel. The edge was machined smooth. It was turned over and the operation repeated on the other edge, thus ensuring that the width of the casting was even all the way along. This operation could easily be carried out on a vertical slide.

The casting was laid flat on the parallel and tapped down to ensure it was well seated as the vice was tightened up. The flat of the vee was machined with a long series end mill. Not everyone is going to possess one of these so, for those without, the operation can be done with a fly cutter. The advantage of the milling cutter was that both faces could be machined at once.

If a fly cutter is used, the casting must be turned over, checked to ensure the vee will be perfectly square, and the second face then machined. In either case, the vee must be checked for squareness after machining.

Marking blue was spread on the edge of the casting and odd leg callipers used to scribe lines giving the thickness required. The casting was mounted the other way round on a parallel and tapped into position. It was machined to size, turned over and the operation repeated.

All that remained was to put it in the vice and machine across the bosses on each side to ensure they were of even height.

A KEATS ANGLE PLATE

The Keats Angle Plate is a versatile piece of equipment which can be used for clamping work of odd shapes and sizes. It can be attached to the lathe faceplate, the cross slide, or the table of the milling machine. They are expensive to buy but a number of model engineering suppliers stock castings suitable for making them. They are not at all difficult to machine, but some newcomers to the hobby will probably find the shape difficult to cope with when setting up. This series of photographs suggests ways in which the work can be carried out.

Whilst most of the photographs show the work being carried out on the milling machine, it would be quite feasible to machine one on the faceplate of a lathe of about 3½ in. centre height. Suggestions on how this can be done are included in the text.

These castings, from College Engineering Supply, are for a fairly small version of the tool. This makes it easy to mount for machining work on the faceplate. The kit comes as two castings and two 10 x 125 mm bolts. Imperial ½ in. bolts can be substituted.

A start was made on the smaller of the two castings. Rough edges were removed with a coarse file and the casting mounted



Left, the large casting before machining. At right, a pair of castings as supplied.





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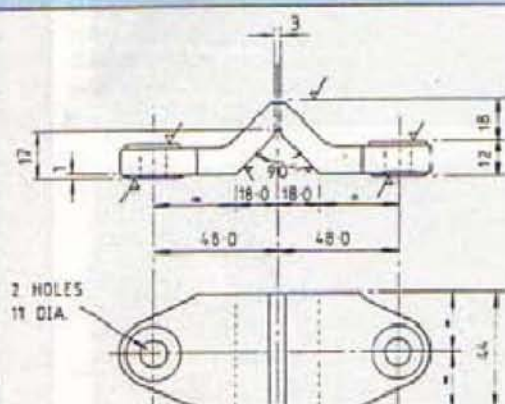
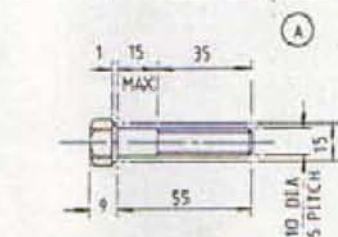
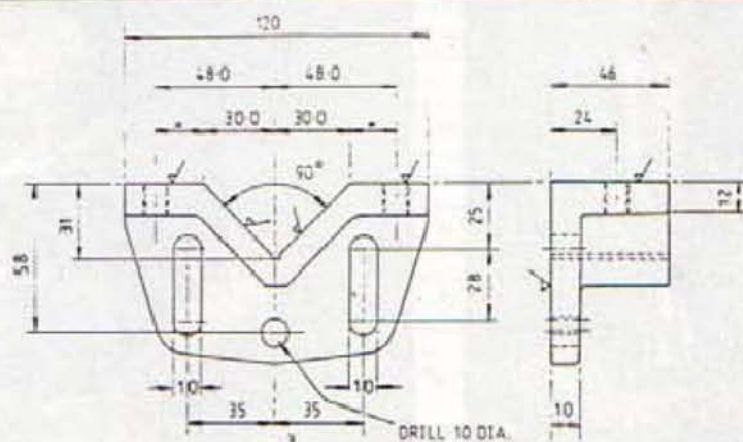
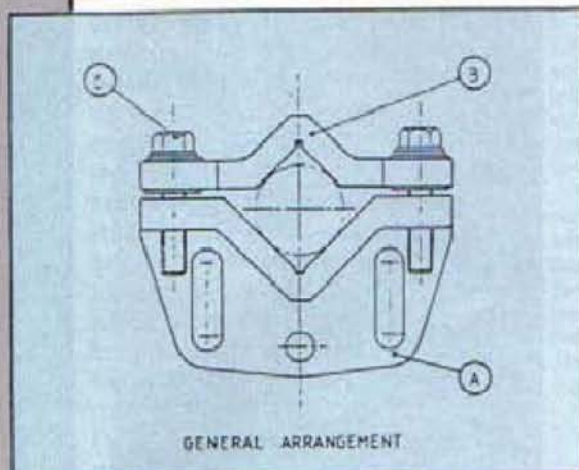
Top row, left to right. The edges of the small castings were machined first to provide a datum. The casting was placed on a parallel end and tapped with a mallet to ensure it was well seated. Machining the vee with a long series end drill allows both faces to be machined at one setting. Centre row, left to right. Whichever way machining is carried out, the vee must be checked with the square. Using odd leg calipers to mark the correct width of the vee, ready for machining the second side. Put the casting in the vice on a parallel. Bottom row, left to right. Use a plastic mallet to ensure it is a flush fit on its seat. Machine the outer vee on one face; turn the casting round and complete the second side. Using a paper template to mark out the slots at an angle suitable for the lathe faceplate.

The large casting

Two slots will be required in this for mounting purposes. It is necessary to machine these in order to mount the casting for further operations, so this must be the first job. The drawings show slots running square; they are better placed at an angle to suit the faceplate on which it will eventually be used. It is understood that future drawings will almost certainly include the measurements for angled slots suitable for the Myford faceplate.

Marking out the slots

Marking out slots at an angle is not an easy proposition, particularly on an odd-shaped casting such as this, so let us look for an easy way out. Get a piece of paper and lay it on the faceplate. Draw a line round two slots with a pencil. We now have the exact position for the slots. Lay the paper on the casting and stick it in the required position. Draw a line up the centre



(B) DETAIL OF CLAMP
MATERIAL: MALL CAST IRON

(A) DETAIL OF ANGLE PLATE BODY
MATERIAL: CAST IRON
STANDARD HIGH TENSILE BOLTS MAY BE USED - 10MM DIA x 55MM LONG OR 3/8" DIA x 2 1/2" LONG C/W APPROPRIATE WASHER. BOLT SLOTS & HOLE DETAILED WILL SUIT MYFORD FACE PLATE.

(C) DETAIL OF BOLT
MATERIAL: H.S. STEEL

TITLE: KEATS' VEE TYPE ANGLE PLATE.		
SUPPLIED BY: THE COLLEGE ENGINEERING SUPPLY.		
TELEPHONE: Tel Colhall (080) 2284	2 SANDY LANE COOSALL WOLVERHAMPTON WV8 1EJ	DWG NO: 558



Left, the row of centre punch marks is lined up using a pointer in the milling machine.

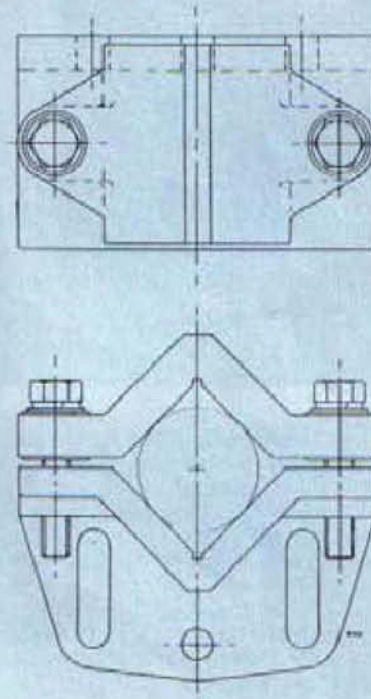


Milling the slots

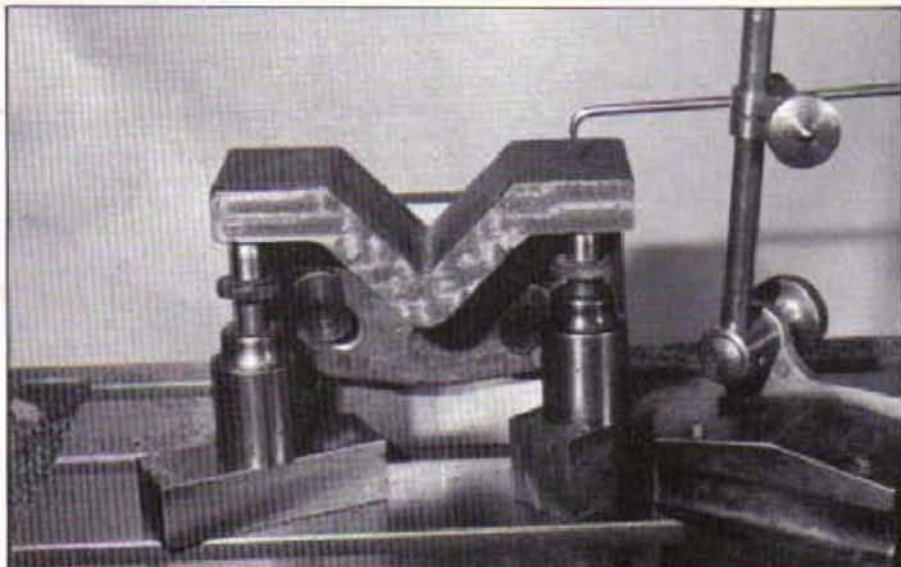
The slots can be machined with the casting held in a swivelling milling vice if one is available. Line up the centre punch marks using a piece of silver steel with a

Left, a slot drill is used to make the slots. Work either to stops or to a dial test indicator as demonstrated in the last issue.

KEATS' TYPE ANGLE PLATE FACEPLATE MOUNTED FOR ECCENTRIC TURNING



THE COLLEGE ENGINEERING SUPPLY



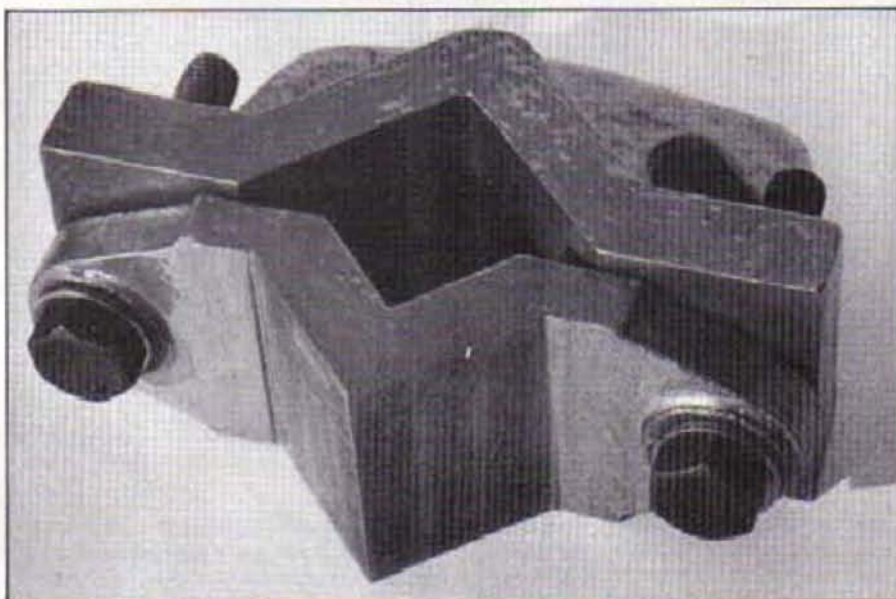
Above; the base can be machined flat with a fly-cutter. This gives a superior finish to an end mill. Below right, a view of the finished Keats angle plate showing the small vee. At foot of page, another study of the completed item, this time clearly showing the large vee and the angled clamping slots. And there we are; a relatively inexpensive and highly satisfying means of acquiring one of these very versatile but often pricey workshop aids.

sixty degree angled point held in the collet, and adjust by eye. If a swivelling vice is not available, clamp the casting on a piece of hardboard with the centre punch marks lined up and run a slot drill through until the sawdust can be seen. If using the lathe, mount the casting on the cross slide on an angle plate, again on a piece of hardboard and mill through in the same fashion.

The upright part of the casting has a slope on it to allow it to be drawn from the mould. This must be machined next. The casting can be clamped via the slot to an angle plate, and is probably best dealt with by flycutting in order to get a good smooth finish. It is as well to support the casting with blocks or jacks during this operation to prevent it vibrating and so causing chatter marks. If using a lathe, bolt the casting to the cross slide and flycut it. Line the casting up square with the faceplate first of all.

It is all fairly straightforward now. The base can be flycut while the casting is held in the vice. If using a lathe, clamp the machined surface to an angle plate with

Below, the casting is mounted on an angle plate using the slots, and tested for level with a scribing block. Screw jacks are used both for levelling-up and for support.



toolmakers' clamps and use a flycutter in the faceplate. The other vee can be machined in the same way as the small casting. The holes for the bolts can be made by firstly marking out and centre punching, and then drilling a pilot hole through the smaller casting. Clamp the two together using identical thickness spacers in each side of the vee and continue the pilot hole through the large casting.

Open the holes out to the correct sizes, tap for the bolts and the job is finished. The drawings show another bolting hole on the large casting. This can have its uses and so it is up to readers whether or not to drill one. The sample work illustrated did not have it drilled, as it is unlikely to be needed. It can, of course, be drilled later if it should be required.

The finished product is certainly very useful, but possibly more important is the fact that this is an excellent exercise in machining odd-shaped castings!



As this issue appears just before Christmas we thought a little item suitable for that forgotten Christmas present might be useful. At the same time, it is a useful exercise in many metalworking skills. It is neither difficult nor time consuming to make, the result is novel and a real talking point at the Christmas dinner table!

For many years, Port Wine has been a favourite after dinner drink, indeed it could be said to be traditional. The Victorian and subsequently the Edwardian upper class families were particularly proud of the vintage Port they were able to serve to their guests and took great pride in dispensing the wine. Whilst a good quality Port will without doubt improve with ageing this also produces a heavy sedimentation process the removal of which created problems. The result was the introduction of the Port pourer.

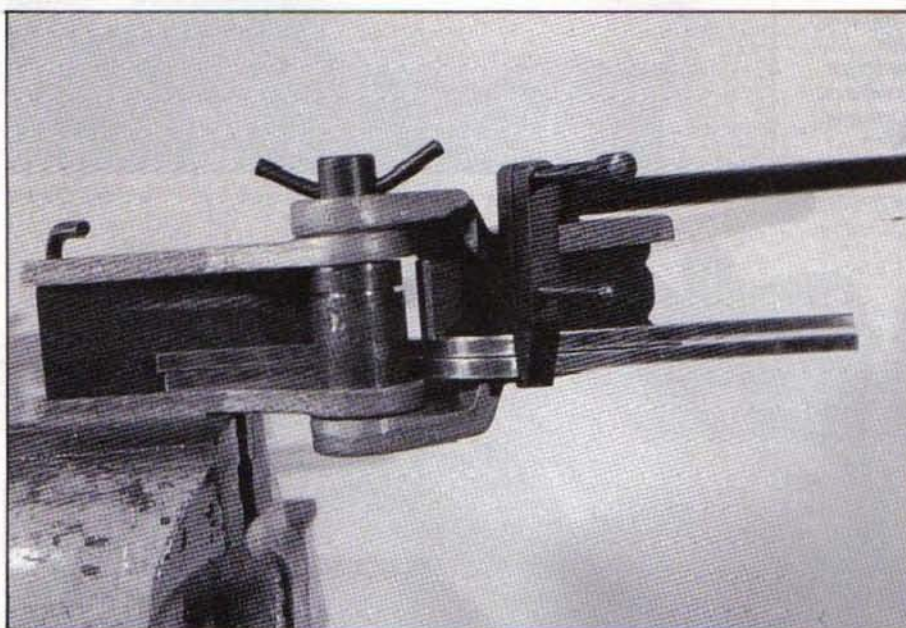
This is a simple device which consists of

example, can be from steel or wood or even aluminium if one so wishes. If silver-soldering is not within the reader's capabilities then the parts can be held together with 1/16 in. dia. rivets.

The bottle holder

This was made from $\frac{1}{4} \times \frac{1}{8}$ in. brass strip. Unfortunately, most suppliers will only sell this as sheared from sheet brass. Tidying up the sheared edges will involve running a file lengthways along the edges to get them smooth and square. The section specified need not be rigidly adhered to,

material. The two longer pieces are carefully bent to the shape of a port bottle. Or reasonably so, anyway. The better the fit, the better the pourer will look. The strip can be softened by heating to a dull red and quenching. It will rapidly harden as it is worked and so softening or annealing will not have a detrimental effect on its strength. Because of the thin section, it is quite possible to bend the metal by hand without difficulty. It is better to use simple guides however, such as round metal bars, or pieces of angle, if sharp corners should be required. Anyone who possesses one of those versatile C.Z. Benders will find that this makes shaping the metal very easy. It also means that two strips can be shaped at once. This is a big advantage; one of the more difficult operations being to get the two lengths to exactly the same shape. The three shorter lengths are curved to the radius of the various parts of the bottle. The smaller one is to nestle just behind the spout. Here again, softening the metal will help. An empty port bottle could be used as a former, if one wished. Check that both



Bottle holder sides are bent to the shape of the bottle; this can be done by hand but if you have a bender (like the CZ tool), so much the better.

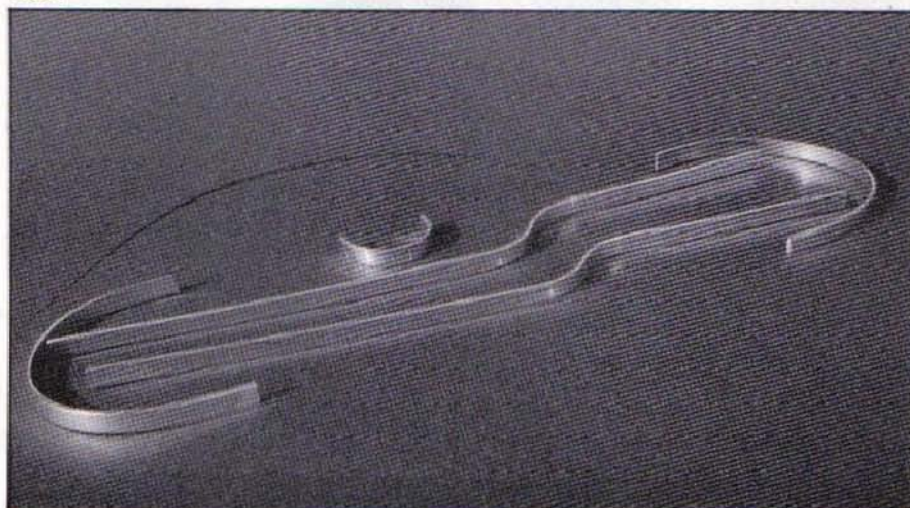
a bottle holder pivoted near the front end. The pivot is connected to a moving arm, operated by a handle. As the handle is wound round, the bottle slowly tips up. The bottles used for port are of distinctive shape, and this shape allows the sediment to be retained as long as the tilting process is carried out very slowly, as is the case with this pourer. These days, the original pourers are highly prized as antiques, so here is a simple design showing how to make one.

Whilst this is something of a departure for *Model Engineers' Workshop* it is in fact an exercise in many metalwork skills. Accurate bending of strip metal, various turning and threading operations, and some silver-soldering are involved. None of the operations in themselves will be found to be particularly taxing, even for the beginner. At the same time, more experienced enthusiasts may want to make the pourer purely for the fun of so doing. Apart from the base and the screw, brass is specified throughout. As brass is expensive, there is no reason why, if the constructor wishes, other materials that are to hand should not be used. The pillars, for

or even $\frac{3}{8} \times \frac{1}{8}$ in. brass would do equally as well. There is also no reason why a slightly thicker section material should not be used, but it will make shaping it more difficult.

We shall need six lengths of the

The sides and supports of the bottle holder after shaping; rear end can be shaped next.

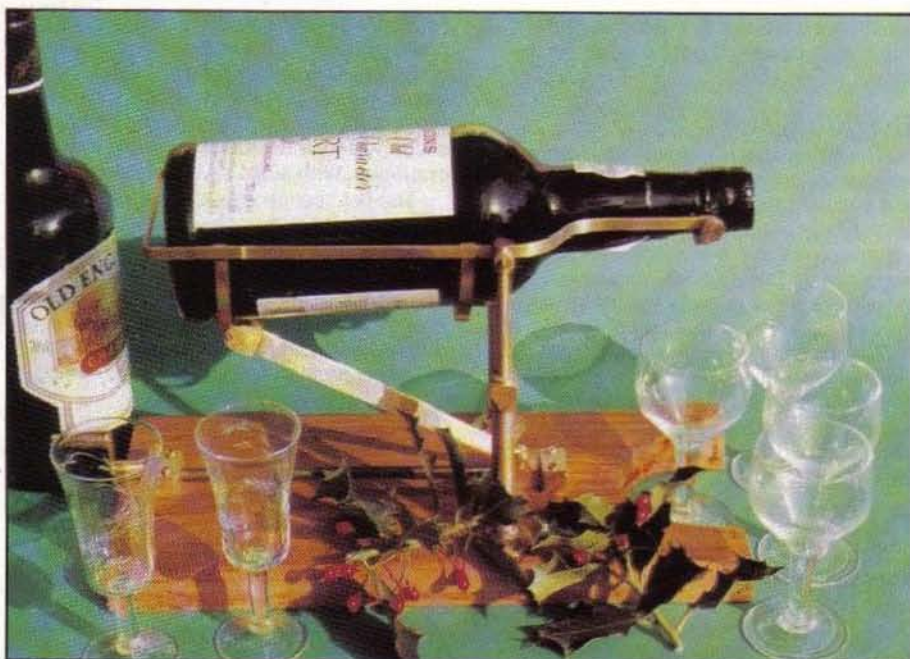


PASS

large radii pieces are the same. Another way of achieving the curve is to use three short lengths of round mild steel strip set in a close triangle in a piece of wood or metal, and drawing the metal through them.

The last piece to be dealt with is the end part. If anyone is particularly good at metal bending this can be made integral with the two sides. Take care, however, as getting both sides and the end right is very difficult indeed. It is certainly not recommended for those without experience.

All the parts are silver-soldered together. A small clamp will be needed to hold them in place whilst silver-soldering. A tiny homemade toolmakers' clamp was used for the model illustrated. Using such clamps for silver-soldering usually means ruining them and so readers might wish to find other methods. A good strong spring paper clip will often work quite well, or it may be possible to just jamb the work against a couple of bricks. Anyway, only do one joint at a time as otherwise things are likely to get out of hand. If a joint goes wrong then with metal of this thickness, there is no reason why the parts should not



brass. The ends to be joined are drilled $\frac{1}{8}$ in. dia. or thereabouts and small pegs of suitable brass inserted to support and locate the parts while silver-soldering takes place. A word of warning here for the less experienced: A small flat should be filed on each peg along the whole length. This allows air to escape when the metal is heated. Failure to do this can give some quite surprising results. It is incredible how far a piece of brass can be projected by air pressure, and also what a loud popping noise it can make. This is not to mention the nasty marks impregnated in it when it hits the floor. Another tip is to pre-flux the parts and to make a small ring of silver solder which will slip over the peg. Heat the

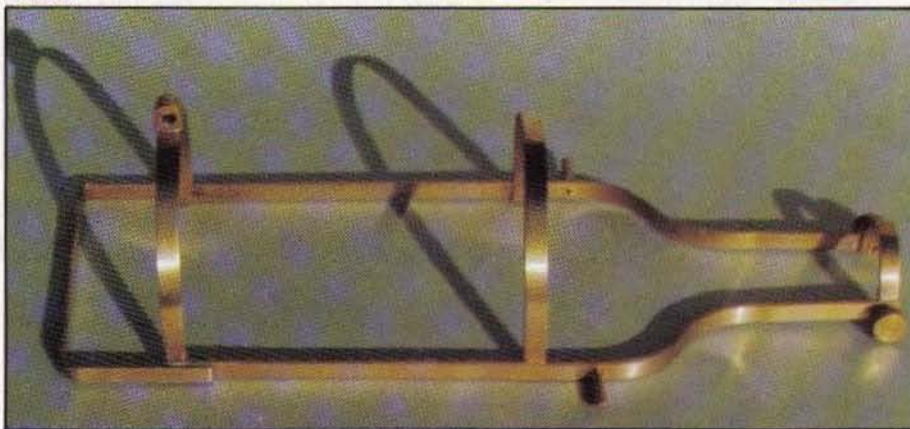
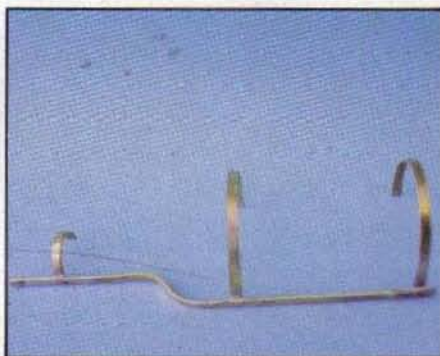
Below, the finished pillar. At foot of page, the parts for the pillar, if they are to be fabricated. Below left, the parts for the bottle holder are silver soldered individually, finishing one side first.

THE PORT!

be separated and rejoined. In the case of the one illustrated, when it came to silver-soldering on the lug for the pivot, it took three attempts to get it right.

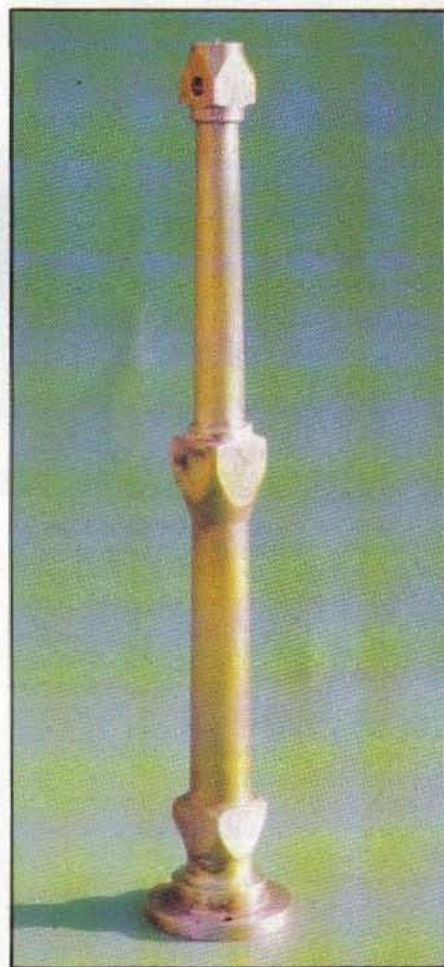
This lug, by the way, is the last part of the frame to be assembled. It is made from a piece of brass. The one shown was carved out of a scrap end of $\frac{1}{8}$ in. dia. material, but of course, square or rectangular material would do as well. Before cleaning the work up it should be drilled and tapped for the pivots, and the bottle holding screws.

The finished item with rear portion added.



The pillars

There is no need whatever to make these to the shape shown. It certainly has no connection with any original, which seemed to be whatever shape the maker fancied. The ones illustrated were made of three separate pieces of metal, shaped and silver-soldered together. They could be made of a single length, if one so desires, and that would have some advantages as there would be no problem of putting the bits together. The main reason for making them from three pieces was to save costs. The bases were made of ends of brass bar $1\frac{1}{2}$ in. diameter. The lower portions from $\frac{1}{2}$ in. square brass, and the top from $\frac{3}{8}$ in. square





hole is not too close to the tapped one. If this occurs there will not be room for the arm to swing about.

The lifting arm

The lifting arm is made from a piece of brass strip, drilled and filed to shape at one end and with the fork silver-soldered to the other. Many of the originals had fancy patterns cut into the arm and if any reader wishes to do this, the only thing to remember is not to make the metal too thin, as it does have to lift a bottle of liquid.

The fork on the end was filed from a piece of $\frac{1}{2}$ in. square brass, after cross drilling for the pin. The slot was filed out and the ends rounded off with a file. As already stated, it was silver-soldered to the arm.

The handle

This was made from a piece of $\frac{1}{2}$ in. dia. brass rod, and a piece of $\frac{3}{4} \times \frac{1}{4}$ in. brass. The brass was drilled to fit the lead screw, and a small section $\frac{1}{4}$ in. dia. turned on the end after it had first been parted off to the required length.

The flat section was marked out and drilled to fit over the piece mentioned above, the other end was then drilled and tapped for the handle screw. The revolving

section was drilled through and counterbored for the screw. Counterbored is hardly the word, as for this job it was simply a case of running a larger drill into the end for a short distance. The handle-securing screw itself was a simple turning operation, with a slot sawn across the end.

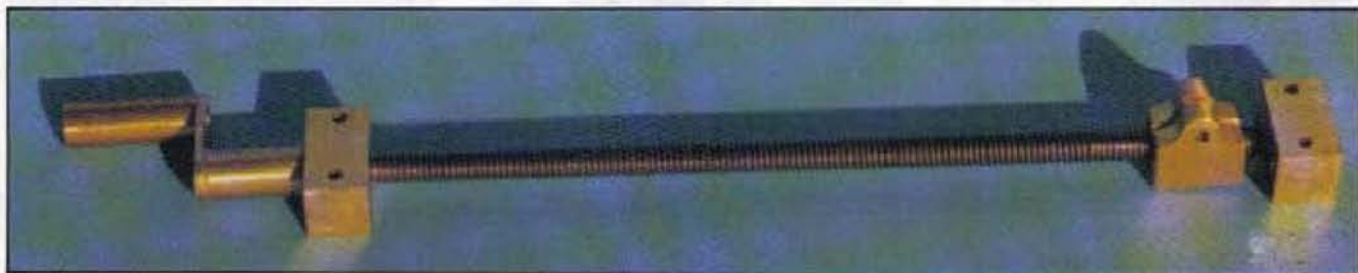
The flat section was silver-soldered to the part that fits over the lead screw; this having first been cross drilled and tapped for the grub screw that holds it in place. The edges of the flat piece were just slightly shaped for appearance. The rotating part was screwed on and the end of the screw filed flush with the flat piece.

The base

If possible this should be made of hardwood, something close-grained for preference. If this is not available, then pine will do but pick the piece carefully so that it does not have any knots in it. The cut-out in the front is to house the glass, and so the sizes shown are not important as long as it will do the job. It should be sanded down as well as possible, and either varnished or polished, depending on one's taste in such matters.

Assembly

Possibly the way to assemble the



parts to be joined until the ring melts, this can save a lot of mess, and is economical on silver solder.

The screw holes in the bases and the cross holes in the top portion were drilled before final assembly, for obvious reasons. The steeper angles on the square sections were made with a form tool, whilst the top slide was set over to an angle of 1 deg. for the longer ones.

The lead screw

Whether or not this is made of brass will probably depend on how much wear the screw is likely to get. For the sample the simple way out was taken. A piece of standard studding was simply turned down at each end, a flat filed for the securing screw of the handle, and the job was done. The bearings at each end were made from $\frac{1}{2}$ in. square brass, these were actually the chucking pieces from the pillars and hence were no trouble to obtain. They are an easy marking out and drilling exercise and merit no description. The best way to get the ends square is probably in the lathe using the four-jaw chuck.

The nut

The drive nut was carved from an end of round bar, obviously a rectangular piece would make life easier. The thread should be cut using the lathe, as it is essential it is square. The slot was first sawn and then opened out with a warding file, after cross drilling the hole for the pin. The actual shape is of no real consequence, care must however be taken to ensure the bearing



Top left, the finished pillars; their shape and profile is optional and readers might like to design their own. Top right, the lifting screw, bearing blocks and handle assembly. Above, the wooden base cut to shape; it needs careful sanding and either polishing or varnishing. Below, the screw assembly on the base; it is important that this lines up exactly along the centre. Also a trial run should be made of the whole pourer to ascertain the best position for the assembly. When the arm is vertical it should be just touching the bearing block near the handle.



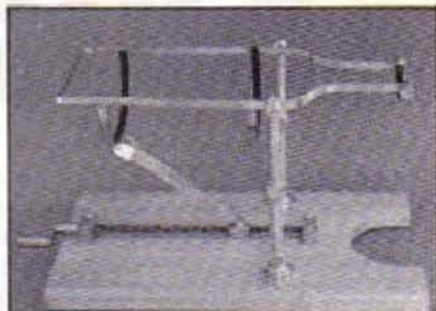
finished parts is a matter of personal opinion, however the following way is known to work. Mark out the position for the bearings of the lead screw, ensuring the screw will be exactly central along the length of the base.

Place the pillars on the base but do not mark the screw holes at this stage. Slip the bottle holder into position, check that it lies centrally along the lead screw and that when tipped up the bottle will empty into a glass. When it is right, mark out one pillar screw hole and screw it down with one screw. Check the position again. If all is well put a screw in the second pillar. Check again, and if correct make the other screw holes and screw the bases down. Put the arms through the relevant slots, and slip in the retaining pins. Put on the handle and tighten up the set screw. Put in a bottle and check that it works.

Finishing

The entire job now has to be dismantled for finishing. If a polishing mop is available, this can be used to impart a really good polish. If not, then we must resort to wire wool. This can be followed with Scotchbright, which can be obtained from the local supermarket, and then a good rub with metal polish. The photographs show the model finished in this way, but it must be said that it has since been given a good polish with a mop and polishing compound and looks much better for it. Finally, a coat of clear lacquer will keep all bright for a long while. Let the lacquer dry thoroughly, reassemble, and try it again. At this point, it is advisable to apply a second coat, taking care that the screw heads are covered, as these are likely to be forgotten.

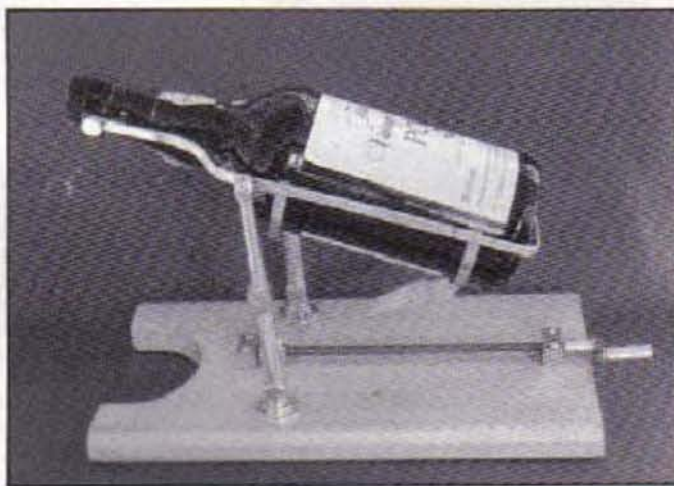
A couple of final touches can be given by putting green baize underneath the



The finished item assembled on the base.

base, and putting strips along the cross bars for the bottle to rest on. If at this point you are able, you may now return indoors and present it to your partner in life who will no doubt find it a most acceptable present.

Below left, the bottle tipped down. The angle does not need to be very steep as the idea is to catch the sediment in the curved section just below the neck - lower the end too much and it will by-pass this recess. Below right, the bottle need not stand fully vertical; an angle of around thirty degrees is entirely adequate, provided that, with the cork removed, the port cannot run out.



QUICK TIP

This tip comes from reader J. W. Thomas:

"I am building a model of a compound linear marine propeller system with pitch control and instant reverse facility which calls for the manufacturer of a number of components in $\frac{1}{4}$ and $\frac{1}{2}$ mild steel and brass plate. I needed a bandsawing machine to do this work, but there is no room in my tiny workshop for one, even if I could afford it, so I looked for a way to employ my 'Black and Decker' jigsaw in such a way that I could get both hands to the work piece and produce parts with clean square edges.

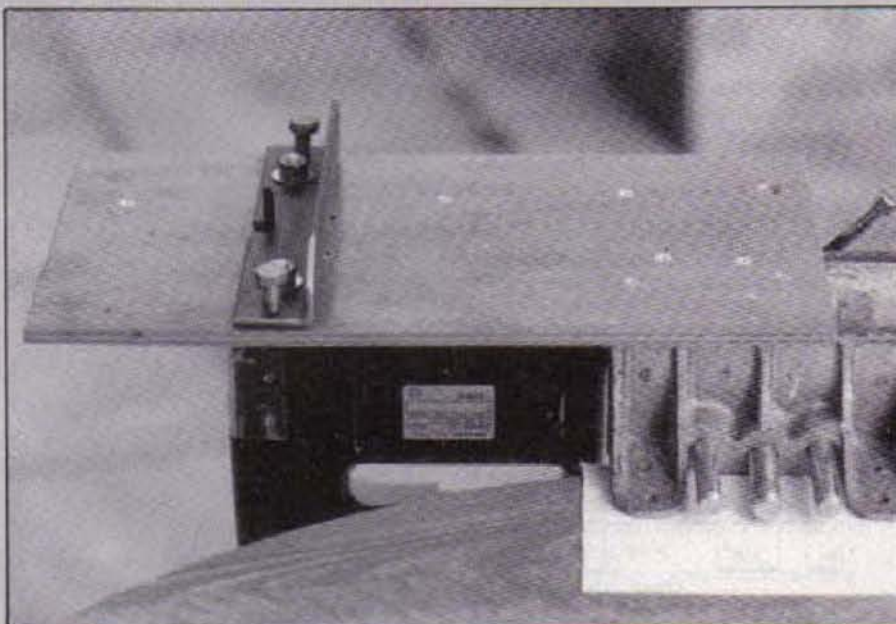
"The photograph gives the general view of the assembly which can be held in an ordinary bench vice; it consists of a sheet of 10mm thick marine ply 16in. long by 8in. wide. The adjustable gate is made from 8in. of $1\frac{1}{2}$ in. x $1\frac{1}{2}$ in. thick mild steel angle. The stiffening beam is 16in. of 2in. x $\frac{1}{2}$ in. oak with a hole to admit a screwdriver when changing blades. The vice block is $4\frac{1}{2}$ in. of 2in. x 1in. hardwood. The beam and block are screwed and glued to the table as shown and the gate is mounted adjustably with two pairs of push/pull $\frac{1}{4}$ UNC hex set screws to give a variable gap.

"In use I found it was important not

to set the gate too high, a clearance of about .004in. over the workpiece was about right.

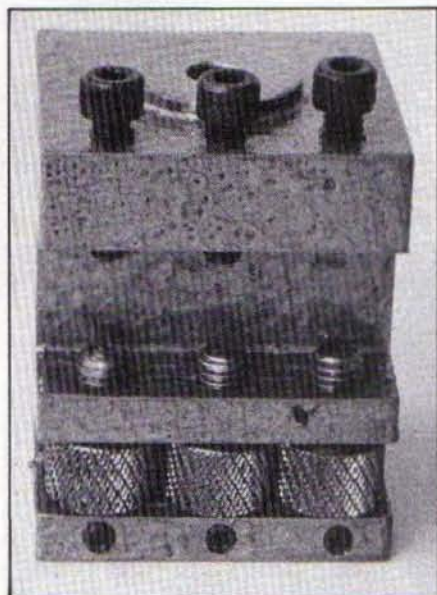
"I have little doubt that your readers will think of improvements and it soon occurred to me that a hinged gate

would be better for swarf clearance and a tubular guard over the blade should be provided. The material cost involved was less than £3.00, and I found what I needed in my dormouse bin."



ADJUSTABLE HEIGHT

One of the most difficult things when using a lathe is to set the tool at the exact centre height – where it absolutely must be! The use of shims is frustrating, usually involving doing up and undoing the tool several times before getting it right. Here we give three simple versions of adjustable height tool posts. Readers may take their pick as to which version is most suitable for their needs



Above, tool post number one, the smallest of the three described here, for the Toyo ML1.

The three types of adjustable height toolpost for which we give details and drawings are just about the simplest possible versions. At a later stage we will be covering the more advanced types. These simple ones work very well, and save that interminable packing up of the cutting tool with shims. Measurements are given on the drawings but these will only suit the lathes for which the toolposts were designed and alterations will be necessary to adapt them to other models. There is nothing difficult in so doing, but check before making one of the posts that it is suitable.

Toolpost number one

The smallest of the three was made for a Toyo ML1 lathe, a rather super little lathe that is no longer available. It is similar in size to the Toyo 210 and the Unimat, so very little alteration will be needed. A suitably sized piece of mild steel or cast iron is faced square at each end and drilled through whilst in the lathe to accept the lathe screw used for securing the post.

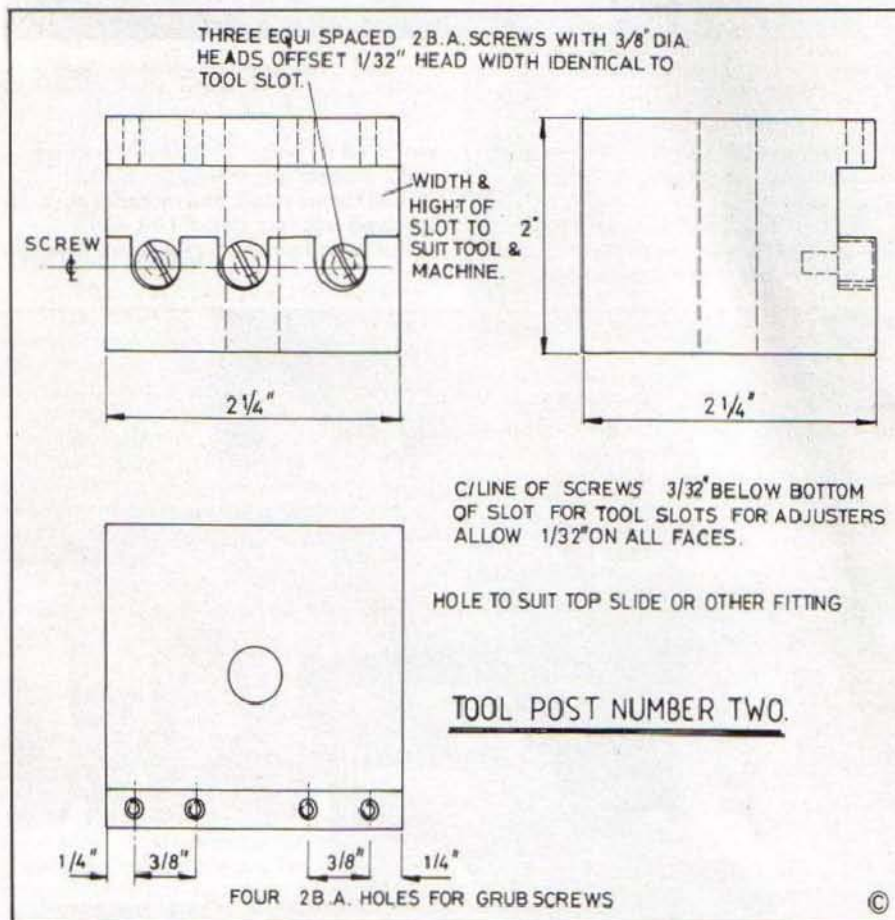
The next job is to drill the three holes



Tool post number two, the slotted screws act as the height adjusters.

from the bottom of the post for the adjusting screws. These are clearance size for the screws to be used. The two slots should be milled but the work can be done from the cross slide if no milling attachment is available. The top slot should be made to suit the size of tool to be used and the bottom edge of it set at a height so that the average toolcutting edge will be just a cat's whisker below centre height when it rests on it. The lower slot must be an exact fit for the adjuster nuts – as these will be made last of all, they can be made to match the slot, rather than the other way round.

Finally, the screw holes for the tool, retaining screws can be drilled and tapped, and the nuts and studs made for the adjuster. Note that the studs have a flat on them which accepts the screws to prevent



Tool post number three from the rear showing clamping screws.

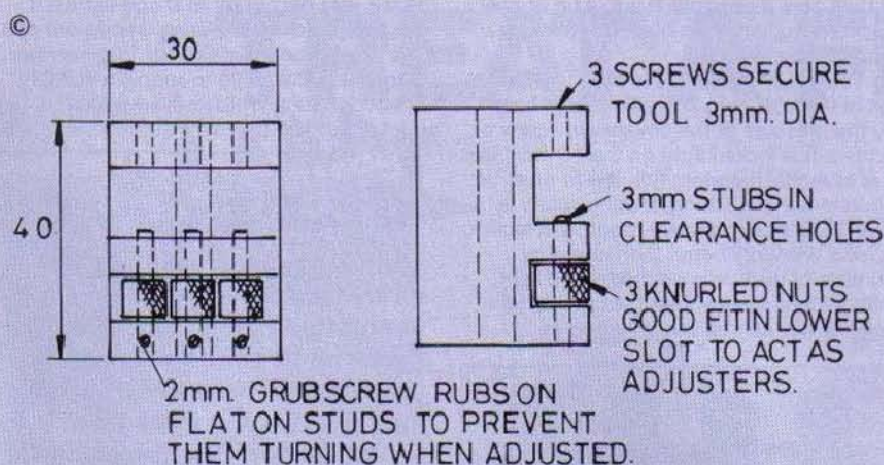
them rotating when adjustments are made. This flat must be fairly accurate or the screws will twist. The nuts are a simple knurling job, but could be made from hexagon material, if one so wished.

In use, the tool is slackened a little and the adjustment made, and the tool then tightened down again. With a little practice it is a simple operation to do. It is also possible to adjust the angle of the tool to some extent by varying the height of the screws at each end.

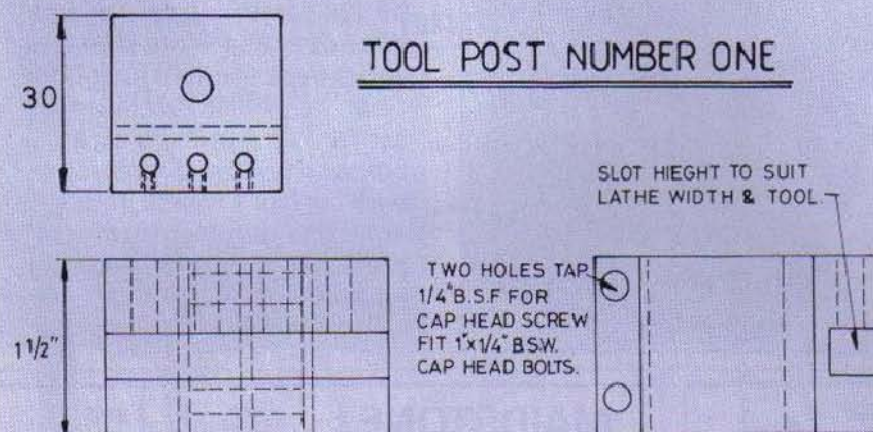
Toolpost number two

Although this was designed with the larger type of lathe in mind, it could probably be scaled down for the miniature type. The adjustment on it is easier to operate than on the toolpost previously

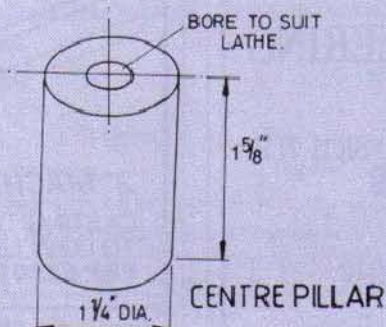
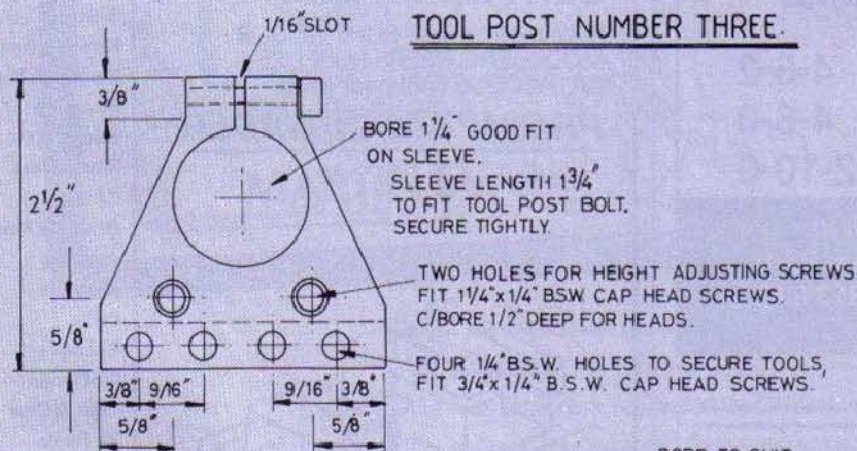
TOOL POSTS



TOOL POST NUMBER ONE



TOOL POST NUMBER THREE.



Tool post number three seen from the top; the height adjusting screws can be seen clearly.

described. The photographs show an adjustable post intended to fit onto the swing clear rear toolpost described in the last issue. With different dimensions, it could just as easily be used in the more normal position with square tools, rather than the parting toolholder.

Once again, a suitable piece of material is faced across both ends to square it off and it is drilled for the securing bolt. The tool slot is milled and then drilled for the adjusting screws. The slots into which the adjusting screws fit are milled in the body. Tap the adjuster holes.

The screws are simply made with rather larger than average heads, off centre. They were made of silver steel then hardened and tempered to prevent too much tendency to flatten when in contact with the tool. The eccentricity need not be great, as little height adjustment is normally needed. It was obtained simply by turning the screws in the three jaw chuck with a



The two parts of tool post number three; a good fit of the parts is essential.

piece of 3/8 in. brass between the stock metal and one jaw; this gave ample offset. The screw slots were then filed with a warding file and they were hardened.

There is no reason why readers should not use hexagon cap screws for the adjusters; this would have the advantage of allowing adjustments to be made with a hexagon wrench. The screw can be put in the three jaw chuck with a spacer but held by the thread. The head can be trimmed to size with a tipped tool.

The final job is to drill and tap the holes for the tool-securing screws and, again, we have a toolpost that is not only adjustable for height but can also be adjusted for angle.

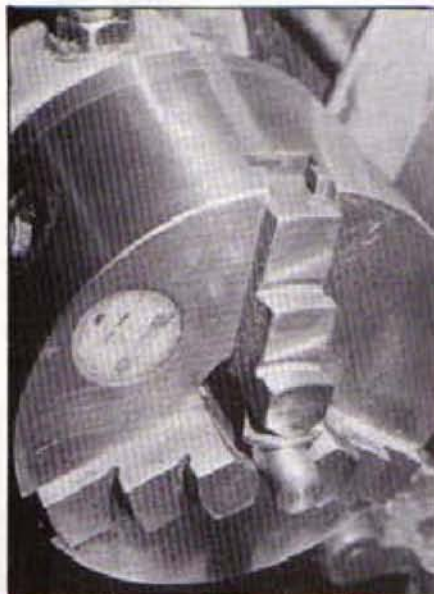
Toolpost number three

This is a different approach to the subject altogether, and is most useful where the operator wishes to change tools and keep the setting, as several different posts can be made to take different tools. The toolpost is designed to fit over the top slide and a suitable piece of steel or cast iron will be required for each toolpost made.

The centre pillar is the first part. It is only a thickwalled tube, but must be a snug fit on the toolpost bolt and must have an outside diameter which will allow a good grip to be obtained on the actual post. In practice, it is bolted down hard on the top slide and left there.

The toolpost is bored to a close fit to the central pillar and the holes for the adjusting screws drilled and tapped. These can be relieved to clearance size for the heads part of the way, to make screwing them in and out a little easier. The tool slot is milled at a suitable height and the top drilled for the tool-securing screws.

The post is then cross drilled tapping size for the locking screw. The hole is relieved to clearance size for half the



Turning the eccentric screws of tool post number two by packing the material with a piece of brass – actually a cut up washer.

length. The first attempt at making the toolpost was done, leaving the square block as it was. It was found that this gave two problems: firstly, the length of the thread and clearance holes for the tightening screws was most impractical. These were relieved by reducing the part of the post where they went through to a more reasonable size. Unhappily, whilst this solved the length-of-screw problem, it was not possible to tighten the holder round the post, because the amount of metal round

the edge made it impossible to spring it. It was therefore first hacksawn and then flycut to the shape shown. This works really well, and allows the post to be held very securely. A slot about $\frac{1}{8}$ in. wide is sawn across the toolpost, best done with a slitting saw, if possible. If not, a bit of neat hacksawing, with two blades in the saw side by side, will do.

That really is all there is to it. The tool is set in the post, which is adjusted to height by the pressure of the downward screw or screws. It is locked tight on the central pillar. It is essential therefore that the fit must be good and that a strong, locking screw is used. If there is sufficient room, two locking screws will work better than one. Any number of posts can be made, and kept with various tools in them set at the right height; they can be interchanged as



required. It is a super addition to the equipment of the workshop if a number of different posts are kept ready for use.

The toolpost illustrated was made from a mild steel section $2\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ in. This worked fine but when it was discovered that it was necessary to shape it, then it became hard work sawing chunks out of it. It is understood that College Engineering Supplies will be able to supply a suitably shaped casting which will save readers a lot of work, if they wish.

QUICK TIP

This tip comes from Mr Maycock of Hythe, Kent. Do you often catch the back of your hand on the point of the tailstock centre when setting up or changing tools on a small lathe? This can easily be avoided by substituting a cork for the offending centre when it is not in use. Note that the cork keeps the tailstock bore clean as well as retaining the centre. My domestic scrap-box was unable to provide a cork for No. 1 Morse Taper, but a few minutes turning produced a suitable wooden plug!

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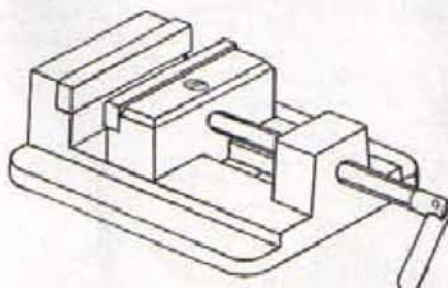
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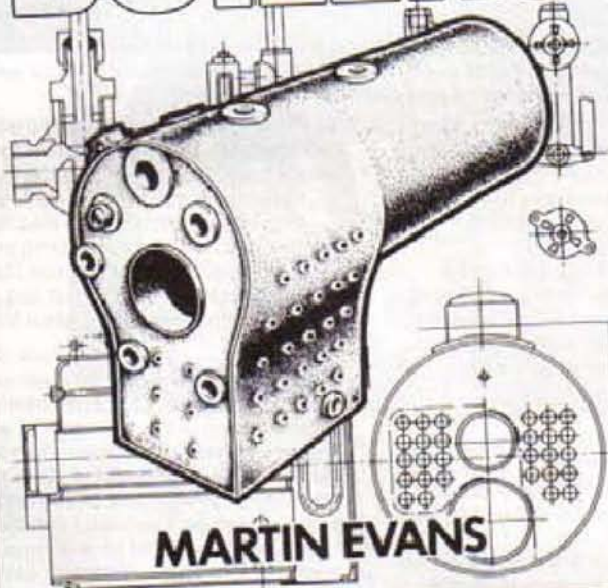
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SPEED REDUCTION OF MACHINE TOOLS

The electronic speed control of machines is something that becomes more common in industry as days go by. Normal methods of speed alterations by belt changing leave one somewhat limited in the number of available speeds, and it can be difficult to find the correct one for the work in hand. Ernest Haddon-Deering has fitted his workshop out with electronic speed controllers of a most successful design. Here he shares his views on the subject with us.

This article arose initially as a result of a letter from me published in 'Post Bag' in *Model Engineer* under the heading *Speed reduction of machine tools*, as long ago as 1986. The letter aroused a great deal of interest and resulted in many enquiries about the unit, being passed through to me. This involved a great deal of correspondence and many trips to the local library to use their photostatting facilities to obtain copies of the drawings and details. The correspondence also concerned the rather unusual motors that I was making use of for my equipment.

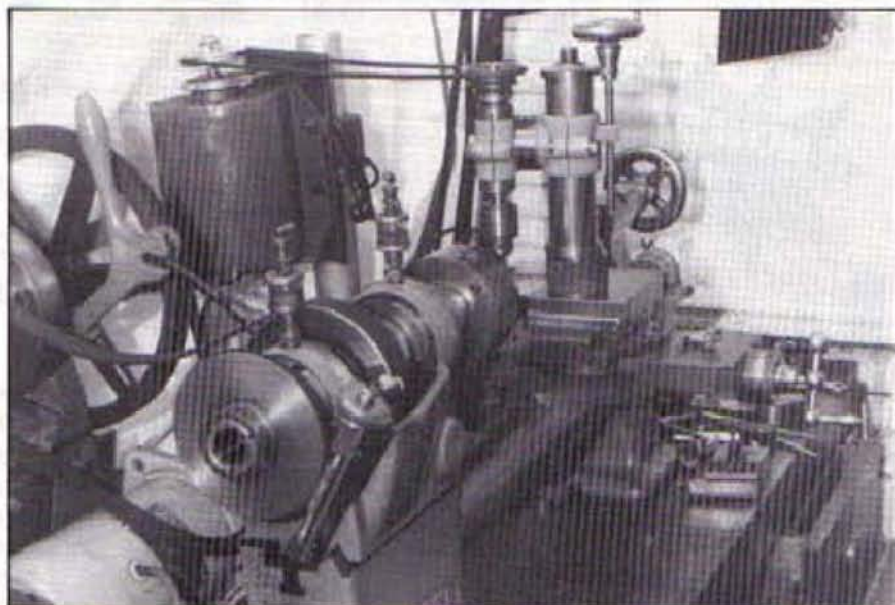


The mill drill machine fitted with a surplus motor and controlled by an electronic unit.

The speed control unit to be described is designed and was originally built by Mr J Shaw; he has business commitments which leaves him no time to handle further requests for information or for units and he has kindly agreed to allow me to pass the information on to all interested parties. Whilst the considerable correspondence, etc., was in no way begrudged, I feel that it is better if details of the unit and the uses it has been put to are passed to a wider circulation in the form of the readership of *Model Engineers' Workshop*. This will allow readers to have all the relevant information and relieve me of the chore of further replies!

Motors

First, regarding the motors, they are



The motor on the author's Excel lathe; the milling attachment can also be seen. All the motors are bought as surplus and controlled by the unit.

taken from obsolete computer equipment. Invariably, computers suffer obsolescence almost from their delivery date as first generation quickly gives way to 2nd, 3rd and 4th generation units, so fast is development in this industry.

My motors came from a scrapped magnetic tape cluster. They are about 10 in. long and 5 1/2 in. dia. with a very substantial square mounting plate at one end of the motor casing. The specification plate reads: 110V DC. Servo Motor. 2.5 Amps. Continuous Rating. Output. 450 r.p.m. 2125 lbs. Split Series Wound. It would be very easy to be put off by such an unusual specification. Very few model engineers would be attracted by 110 Volts and only 450 r.p.m.

Be assured that Mr. Shaw's marvellous control box overrides such small details. Just plug into 240 v AC and out motor delivers from about 80 r.p.m. to well over 2,000 r.p.m. with a twist of the control knob and with practically no power loss in the lower revolution range. I would guess that they deliver about 1/2 h.p. judging by the former performance of the replaced standard 1/2 h.p. motors. They are very robust and become barely warm after continuous use over a long period.

Use on a lathe

The motor driving my 4 in. Excel lathe provides a long-desired equivalent to a back-gear. Nearly 2 in. dia. bronze and mild steel has been parted off without difficulty. The Excel is a copy of the Boley Leinen and my reason for purchasing a new plain lathe was to ensure that all the cost went into a massive high-precision headstock, the hollow mandrel admitting 1 in. through and an equally massive long travel slide-rest. Model screwing tackle is mostly taps and dies, so none of the cost was absorbed by expensive lead-screws, apron, change wheels, etc.

However, I must admit that there were times when a nice auto-feed for long work would have been very welcome indeed...

I eventually acquired a 4 in. Round Bed Drummond lathe (long bed) also non back-gear, but having screwcutting and auto-feed facility. This lathe also now has an efficient back-gear equivalent and a very useful slow travel which is ideal for screw-cutting.

Use on a mill drill

The third motor is on my milling/drilling machine. This unit is the result of a successful marriage between a Walker-Turner drilling machine and the compound slide-rest assembly of a Dore-Westbury milling machine. The motor handles the slow speeds required for milling cutters and the higher drilling speeds admirably.

Other uses

The fourth motor drives a home-made jigsaw machine which was improvised, using a nice dural casting, also a scrapped computer component. The saw is operated by an adapted Heywood Compressor, ex-Government Surplus. It can take coping saws, junior hacksaw blades and jewellers' piercing saws, the slow feed being invaluable to counteract breakage of the

Motor No. 2 as fitted to the author's Drummond round-bed lathe.



fragile piercing saw blades.

The photograph of this unit also shows a Bosch Router mounted under the bed-plate. In use, the saw blade is removed and a simple fence fitted. The router motor gives a speed of 26,000 r.p.m. and has proved to be extremely useful as part of my effort in making cases in mahogany for some old clock movements. The outfit looks very Heath-Robinson, but it works well.

At the moment, I use two controller units. One is swapped between the two lathes and the other is shared by the jig-saw and the mill/drill. I am now arranging for all four motors to have separate controls. Two basic electric units are available, but require boxes, reverse switches, rheostats, fuses and on/off lamps. The fore and aft photographs of the units clearly show the placing of the various components. The operation sheet is fully explanatory and points out that other types of DC motor may be operated through the units.

I regret to say that it will be useless to write to me for further information as my knowledge of these matters is absolutely nil! Apart from one minor incident, I have enjoyed eight to nine years trouble-free

usage; the one incident being a blow-out from one of the motors, due to carbon dust tracking between two of the four brush-holders. The brush-holders are mounted on a 3 in. square of $\frac{1}{16}$ in. thick Tufnol or Bakelite or some similar material. A replacement was quickly made with some material from my stock and using the faulty square as a drilling jig. The electronic units have operated faultlessly throughout, I confess that the original motors were retained by me just in case. An unnecessary precaution.

Operation of SC2B speed control

A.C. power is applied to terminals (11) (live) and (12) (neutral). Current flows through the switch and fuse (max 6 amps) to the indicator lamp and remaining circuitry.

The filter components, L1, L2 and C1, prevent undue harmonics from the phase control switching appearing on the supply line. Diodes D1 through D4 form a full-wave rectifier for the field coils of a shunt motor and Z1 (surge suppressor) prevent induced voltage spikes damaging the diodes.

Diodes D7 through D10 are the armature

rectifiers, control of the armature being achieved by switching the AC input to the bridge.

Triac T1 is the switching element of the armature control and is triggered through a 32 volt Diac from the CR network formed by C2, C3 and the resistors around VR3. VR3 is the variable control with VR1 and VR2 used to present minimum and maximum speeds respectively.

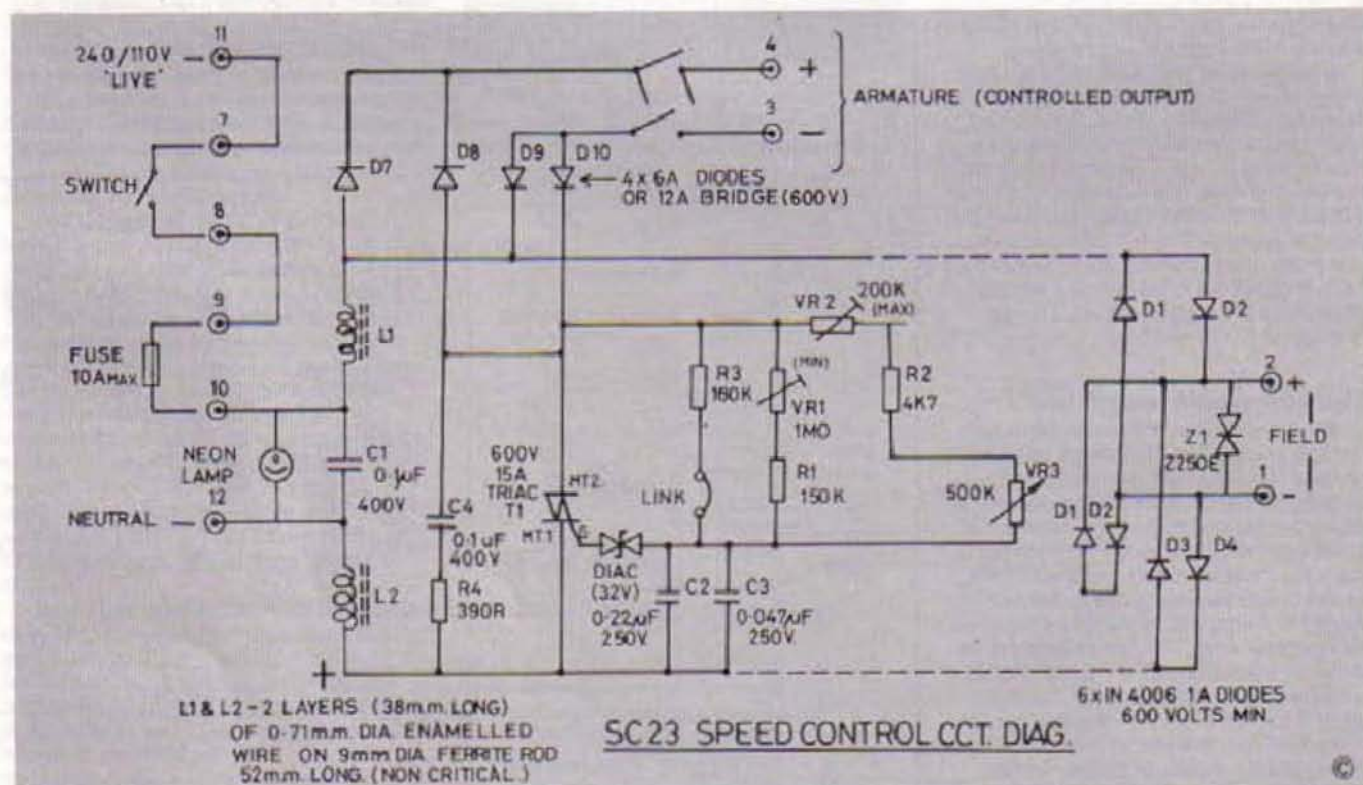
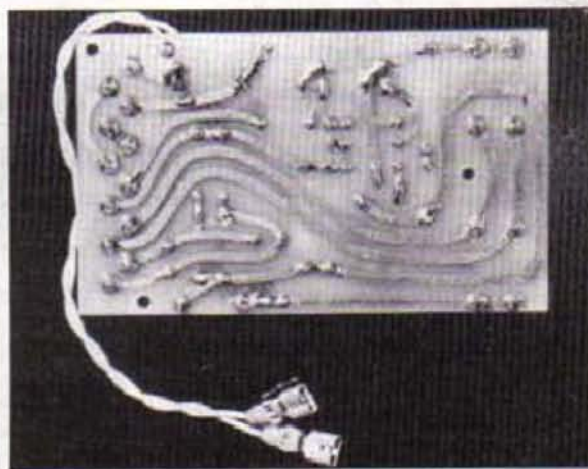
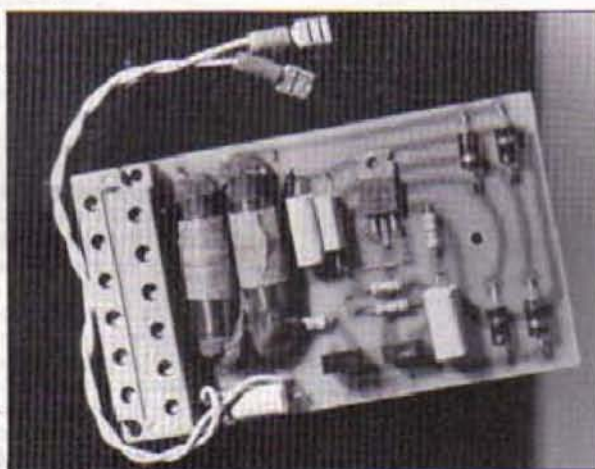
When used on 240 volt supplies, the link in series with RE is omitted; this ensures the control range of the CR circuit. When operated on 110 volt supplies, the link is included for the same reason.

D5 and D6 provide feedback of induced back-EMF during deceleration to maintain a smooth control of shunt motors. For use with split series motors, as used by Mr Deering in his homebrew machining centre, the motor uses only the armature output, the field terminals being ignored, so for ease of reading the diagram, the field circuitry has been omitted.

PLEASE NOTE: It is NOT recommended to switch from one direction to the other whilst the motor is under power (a practice known as 'plugging') as this causes high current surges which can damage the controller.

Far right, the basic electronic unit from the rear.

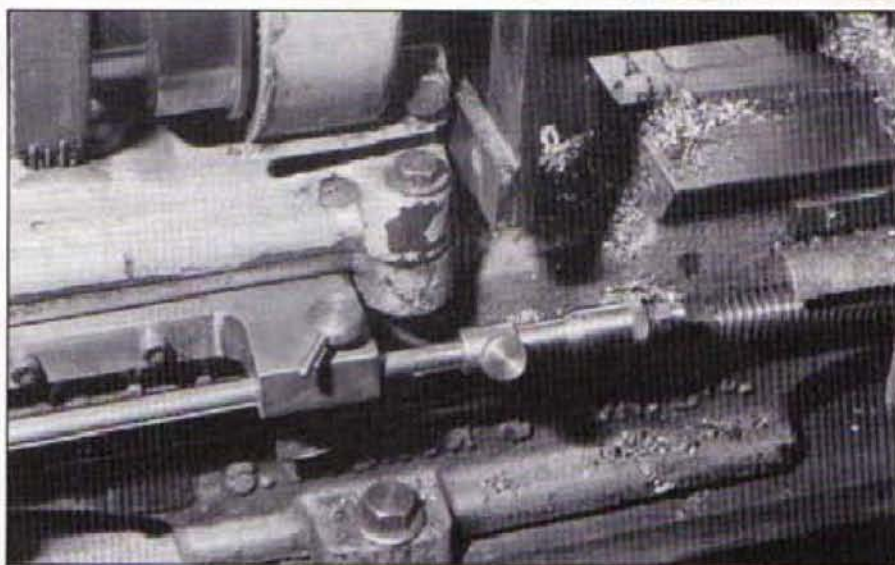
Near right, the basic electronic unit seen from the front.



MICROMETER STOPS

In the last issue Les May gave us an article on a milling attachment that has proved to be highly popular. In this issue he relates how to get greater precision by using stops that are adjustable on a micrometer scale. As usual, he also describes how to go about the various tasks and make the jigs needed for the construction. Many readers will find that even if the stops themselves are of no interest other sections of the article will be of value.

The micrometer stop, which is described in this article, is for use in controlling accurately the movement of the saddle on any lathe of traditional design such as Zyto, Myford etc. It can, with relative ease, be adapted for use on a



A close-up of a micrometer length stop mounted on the author's Zyto lathe.

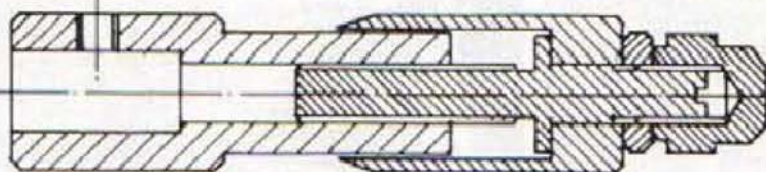
The bracket

The bracket is the next item. The dimensions of this must be to suit the lathe. One sketch shows a bracket suitable for the Zyto. The main point to be borne in mind is that the $\frac{1}{2}$ in. reamed hole brings the stop truly in line with the selected spot on the saddle against which the stop is to bear. On the Zyto it is the edge of the apron as can be seen in the photograph. A small area of this has to be filed true to give a good bearing for the stop. The second sketch gives the dimensions for a bracket that is easily made and fitted to the ML7. The micrometer stop butts against a machined face on the saddle. It may be necessary to scrape away the paint locally to reveal bare metal.

The micrometer head

The movement of the micrometer head has been limited to $\frac{1}{2}$ in. and this has been found adequate for the majority of turned work encountered in model engineering.

SECTIONAL G.A. OF MICROMETER HEAD

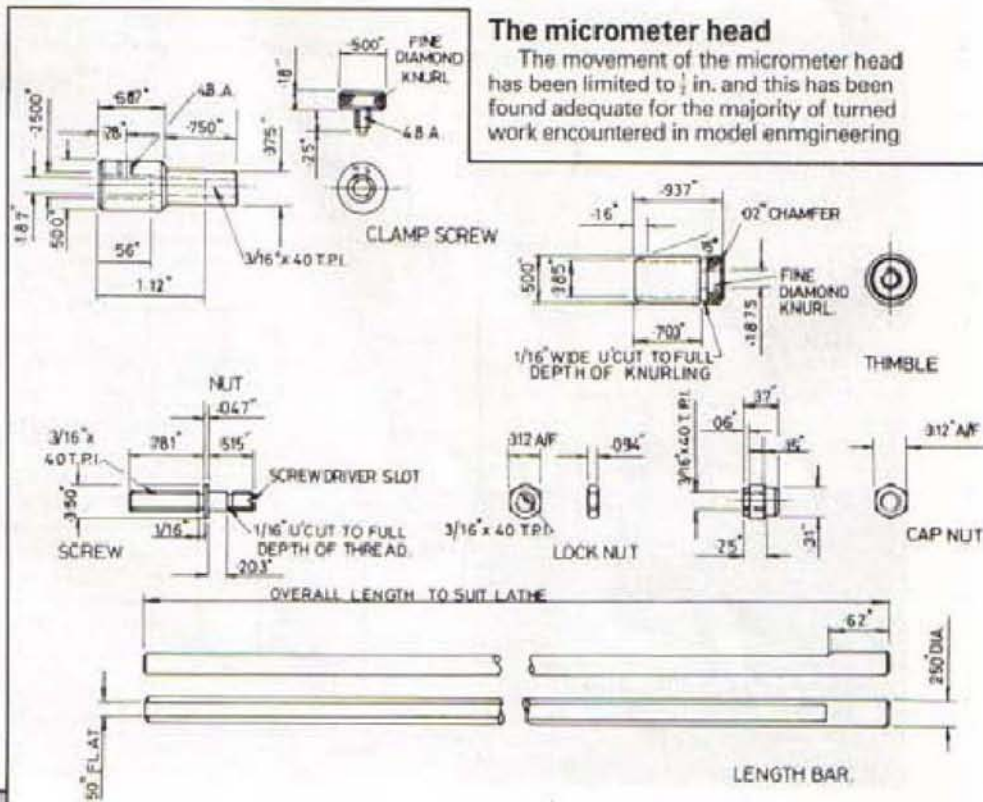


MICROMETER STOP FOR SADDLE OF $3\frac{1}{2}$ " CENTRE LATHE

milling machine or cutter grinder. As will be shown, it can also serve as an inside micrometer for larger diameters by the addition of standard length pieces, provided you have a means of measuring and adjusting such pieces accurately.

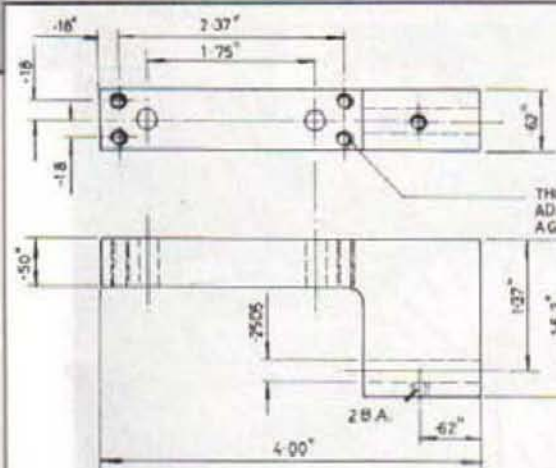
On lathes that are made without a gap bed, it is normal practice to clamp the stop to the bed sideways. This is the simplest and most convenient way of doing the job, but, as many model engineers' lathes are of the gap bed type, it is necessary to arrange a bracket to carry the micrometer head and its extension rod. This is best positioned just below the headstock. Very frequently, Myford lathes are fitted with the Norton type gearbox. Where this is so, it is not possible to fit the bed stop.

only $\frac{1}{2}$ in. at one end, the full $\frac{1}{2}$ in. dia. This flat must be evenly filed for its full length, so frequent checks with a micrometer are vital.

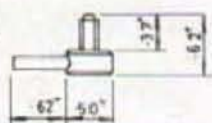


The adjustable length bar

We will deal with the adjustable length bar and bracket first. The length bar is just a piece of $\frac{1}{2}$ in. dia. silver steel of a length suitable for the lathe. On the Zyto lathe, for which the original stops were constructed, it came out to 8 $\frac{1}{2}$ in. overall. If it were made any longer, the left-hand end would have fouled the screwcutting change wheels when fully retracted, as would be required for faceplate work. The two ends are to be faced off square and a very slight chamfer is made at each end to remove the sharp edge. A flat not less than $\frac{1}{2}$ in. wide nor more than $\frac{1}{2}$ in. is filed, or machined, for almost the full length of the bar, leaving



BRACKET SUITABLE FOR
ZYTO LATHE



activities. Additional length can be added to the range by having one or two extra cap nuts in increments of 0.500 inch.

We will deal with the nut first. This is made from a piece of $\frac{1}{8}$ in. dia. mild steel 2-2 $\frac{1}{2}$ in. long, alternatively, it can be turned on the bar if it will pass through the headstock spindle of your lathe. Hold it in the 3-jaw chuck with not less than 1 in. projecting and turn down the outside diameter to 0.375 in. for a distance of $\frac{1}{8}$ in. A good finish is required on this diameter. If necessary, use emery cloth to achieve it. A small chamfer on the $\frac{1}{8}$ in. diameter for appearance's sake completes the turning thus far.

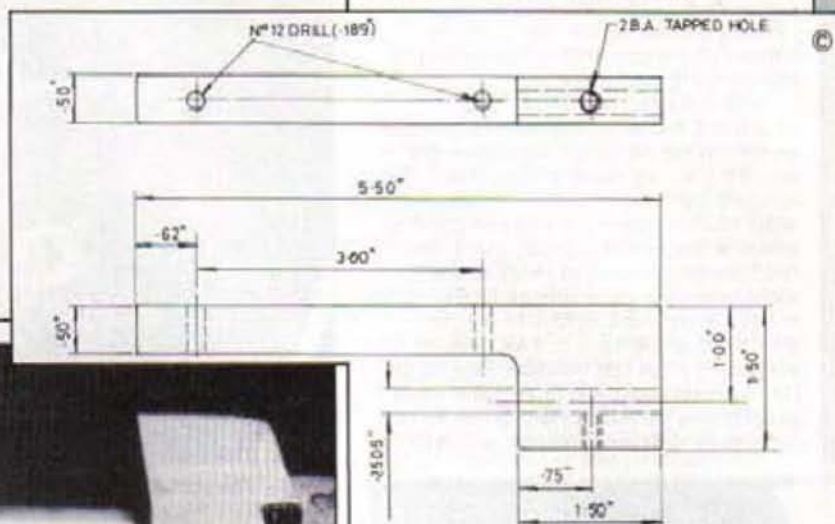
At this relatively early stage, it is worth carrying out the marking, then, if anything goes wrong, you have wasted the minimum of work.

Grind a tool to the same shape as a screwcutting tool, i.e. an included angle of about 60 deg. with a slightly rounded tip. Turn the tool on its side and set it so that the tip is at centre height, cutting edge towards the chuck, of course. Bring the tool up to the work until it just touches, note the number on the cross slide dial and wind the tool clear. With the saddle, move the tool just clear of the right-hand end of the work, then advance the tool to 0.003 in. beyond the noted position and run it the full length of the 0.375 in. diameter. This will give you a scribed line with a small burr, which can be stoned off later.

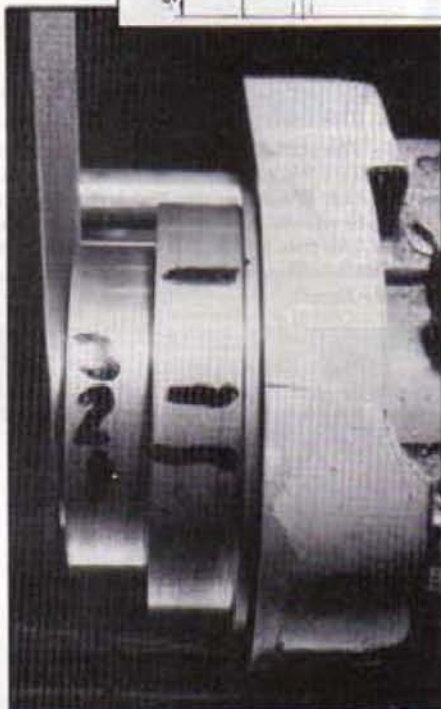
The marking of the 0.025 in. division lines is probably the most tedious part of the whole job. It is not difficult, but it does require concentration, care and patience. The first operation is to grind the marking tool point at about 60 deg. included angle as for the previous operation, but this time it is necessary to have what, in normal cutting terms, would be described as excessive clearance. This is because the tip of the tool is going to be driven into the work by about 0.003 inch. The additional clearance makes this possible without undue strain on the lathe or the tip. Grind it, as near as you can by eye, to look as the sketch.

Next, check that the topslide is set parallel to the workpiece by using a dial gauge or use feeler gauges between a piece of brass clamped in the toolholder and each end of the 0.375 in. dia. of the work. Now, three different lengths for the markings are required. The 0.1 in. marks should be about $\frac{1}{8}$ in. long, the 0.05 in.

marks $\frac{1}{8}$ in. long and the 0.025 in. marks $\frac{1}{8}$ in. long. To get these looking regular and consistent, it is necessary to have fixed reference points. I used a line made with a felt-tip pen on the back-gear guard close to the large lathe pulley and four felt-tip marks made on the pulley, which correspond the three starting positions for the tool and the finishing positions.



BRACKET SUITABLE FOR ML7 LATHE

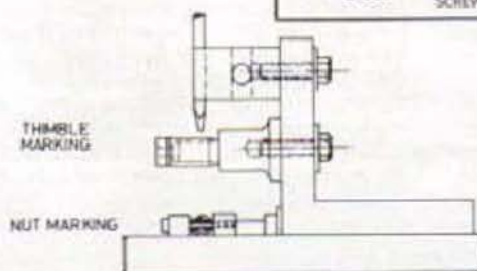
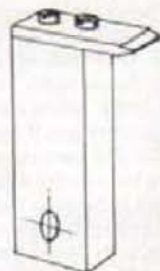
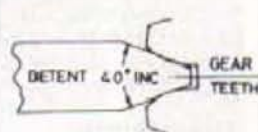
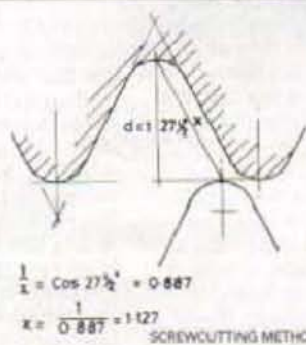
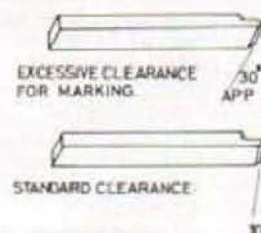


A felt tip marker pen was used to mark the flat belt pulleys with the positions adopted during the marking out of the micrometer head.

To establish these positions, clamp the scribing tool in the tool post as for normal turning. Next, using the topslide, ensure that you can get the tool up to the work along the full length of the 0.375 in. dia. without fouling anywhere.

Now, bring the tool up to the work as close as you can without actually touching it. Rotate the lathe by hand and, using an eyeglass, set the tip of the tool to coincide with the horizontal line previously marked. Mark the backgear guard and the lathe pulley with coinciding felt-tip marks. This gives the finishing position for all the marks. The starting positions are established by measuring back from the finishing mark $\frac{1}{8}$ in., $\frac{1}{4}$ in. and $\frac{3}{8}$ in. Number them 1, 2 and 3 respectively.

Now the actual markings can be made. With number 1 mark in line with the mark on the gear-guard and with the tool tip $\frac{1}{8}$ in. from the shoulder, advance the tool until it just touches and then feed in a further

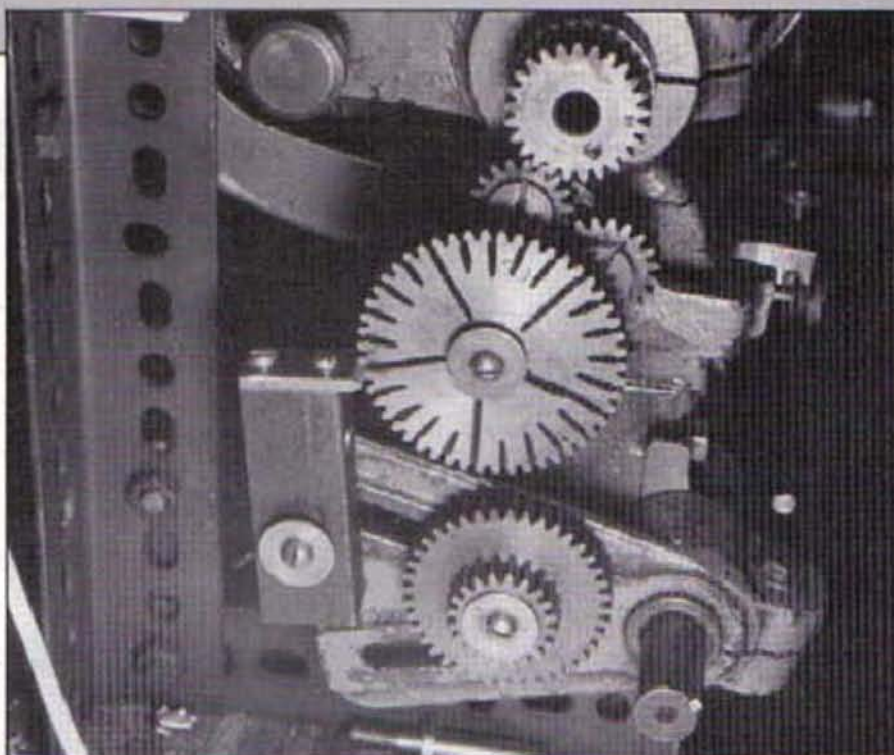


INDEXING DETENT FOR THIMBLE MARKING

SUGGESTED SET-UPS FOR MARKING

0.003 in. on the dial. Rotate the pulley until the finishing mark lines up and withdraw the tool. Set the collar on the topslide to zero, then advance the tool 0.025 in. and make the second mark starting from No. 3 position. Do the same again starting from No. 2 position, then again starting from No. 3, advancing the tool on the topslide by 0.025 in. for each mark. Repeat this 1, 3, 2, 3 sequence until you have marked the full $\frac{1}{2}$ in. range of the micrometer. Carefully remove all the burrs left by the marking to complete this part of the job.

With this operation successfully concluded, the remaining turning operation on the nut can be continued. Centre drill and drill $\frac{1}{8}$ in. to a depth of $1\frac{1}{2}$ in. then carefully tap this $\frac{1}{8}$ in. $\times 40$ TPI to about $\frac{1}{2}$ in. deep. Hold the tap in the tailstock chuck to ensure a thread that is axially true in the nut. Change to the 4-jaw chuck and with some brass or copper strip about 0.01-0.02 in. thick to protect it, hold it on the $\frac{1}{8}$ in. diameter and get the $\frac{1}{8}$ in. hole running truly using a dial test indicator. Face off the $\frac{1}{8}$ in. diameter until 0.687 in. remains. Work as accurately as you can with a rule for this dimension. It is possible to get within 0.005



Above: The detent, and the felt tip pen markings on the lathe changewheel used for setting out the graduations on the thimble.

Left: Linear dividing from the lathe's leadscrew was the method adopted to graduate the micrometer body, the numbers were incised later.

Below: The tool set-up for graduation of the thimble, tool travel is controlled by the topslide leadscrew. Dividing is controlled by the changewheel and detent set-up already shown.



in. if you are careful. Now open up the $\frac{1}{8}$ in. hole to 0.389 in. (number 12 drill) to a depth of 1.120 in. The next operation is to open up the number 12 hole to half a thou over the nominal 0.250 in. to suit the length bar. A square shoulder is required at the bottom of this hole so it will be necessary to use a boring bar that will produce a nice square and sharp corner. To complete the nut a 4BA tapped hole is required to take the clamp screw. Drill and tap it in line with the longitudinal reference line on the nut.

The thimble

For the next item, which is the thimble, you will need about 2 in. of $\frac{1}{2}$ in. diameter mild steel or, as mentioned earlier, you can turn it on the bar if your lathe is suitable. It is worthwhile getting the outside diameter of this running really truly because the 15 deg. chamfer will make any eccentricity more obvious and this would spoil the look of the job. So start by setting the work running truly in the 4-jaw chuck. Have sufficient projecting from the 4-jaw chuck to enable you to get the knurling tool into position with about $\frac{1}{8}$ in. to spare. Face and centre drill the end, follow up with an $\frac{1}{8}$ in. drill taken in $\frac{1}{8}$ in. deep measured to the tip of the cone. Bore to 0.385 in. diameter to a

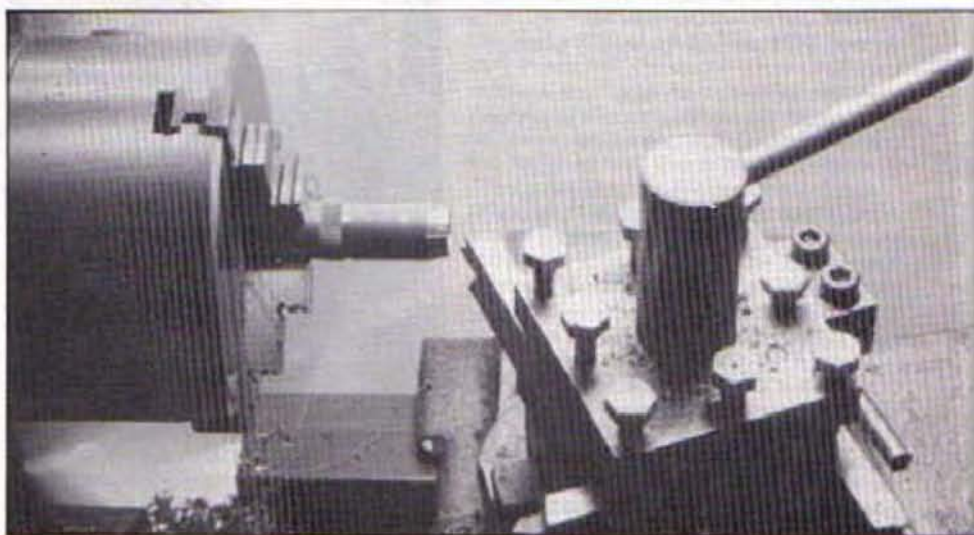
depth of 0.703 in. ($\frac{1}{4}$ in.). Get this dimension as close as you can with a depth gauge rule and face across the bottom of the hole to give a good flat face for the collar on the screw to butt against. Re-centre the bottom of the hole and drill No. 14 (0.182 in.) and ream $\frac{1}{8}$ in. Just remove the sharp corner on this hole with a $\frac{1}{8}$ in. drill held in the hand. The top slide can now be swung round to 15 deg. to the axis of the lathe for machining the coned part of the thimble where the index marks will be made. A good finish is required here also. Stop machining the coned portion when a $\frac{1}{8}$ in. wide land remains on the end face. Take a look at the scribing tool and if the tip is still O.K., set it on its side with the point at about centre height. Before any index marks can be made, some arrangements have to be made to control the spacing of the divisions. This will be done by using a 50 tooth change wheel as a division plate. Complete instructions cannot be given here

because the final details will be dictated by the type of lathe that you have. The general principle can be seen in the photograph and the somewhat crude method of construction is shown in the sketch.

Divisions

It is worth paying particular attention to the shape of the detent. It should be made straight-sided like the teeth of a rack and the flat on the end should not bottom in the teeth of the gear wheel. When in use, it will probably be found that any attempt to turn the lathe by hand in one direction results in a positive engagement of the detent, while turning in the opposite direction tends to eject it. It is obvious that the marking should be carried out in the direction that gives the positive engagement.

The 50 tooth wheel is mounted on the stud gear position, i.e. immediately after the tumbler reverse assembly. The detent



arm, swings on one of the gear train spindles. As can be seen from the photograph, I found it an advantage to mark the gear wheel with a magic marker felt-tip pen indicating the short and long marks on the thimble.

With the detent engaging one of the gear teeth having a long mark, bring the tool tip up to the coned part of the work until it just touches, lock the saddle and set the cross slide index to zero. Wind the tool clear with the cross slide and move it to the right of the work with the top slide. Advance the cross slide to 0.003 in. beyond the zero and then, with the top slide, run the tool across the coned part of the work. Index round one mark and this time stop the tool at a little more than half way across. Set the index on the top slide to zero, then wind the tool to the right, clear of the work. A little curl of swarf will be left, which will later be removed with a fine file.

Continue round the thimble taking the short marks up to the zero and the long ones right across until you come back to the starting point. Put the tumbler reverse gear into the mid or neutral position and, with the lathe running at normal speed, remove the curls of swarf with a fine file and give the thimble a final polish with a piece of fine or worn emery cloth.

Now the knurling operation can be carried out. A fine diamond knurl looks best, but a straight knurl is acceptable, some may even prefer it. To get a good start and to avoid a double knurl appearing, it pays to turn the tool at an angle of about 15 deg. to the job. The corners of the knurl wheels dig in firmly and produce a full depth imprint with both wheels. The tool can then be swung back square with the work and sufficient pressure applied to produce a full knurl. Nothing looks worse than a diamond pattern with flats at the top. The $\frac{1}{8}$ in. wide undercut is intended to

tidy up the edge of the knurled band which, if left unmachined, looks rather scruffy. When this is complete, the thimble can be parted off to a little over the length shown on the drawing. The end can then be faced off down to size and the corner of the knurling chamfered. This completes the thimble.

Cutting the screw

We can now turn to the screw, which is the essence of the tool. To think of producing an accurate thread with a standard $\frac{1}{8}$ in. O.D. split die is just not on. However, you may get away with it if you are fortunate enough to own a 1 in. O.D. die. These are usually $\frac{1}{8}$ in. thick, therefore the pitch error is less likely to be troublesome, as a greater number of pitches is controlled by the die. The safest way is to resort to screwcutting.

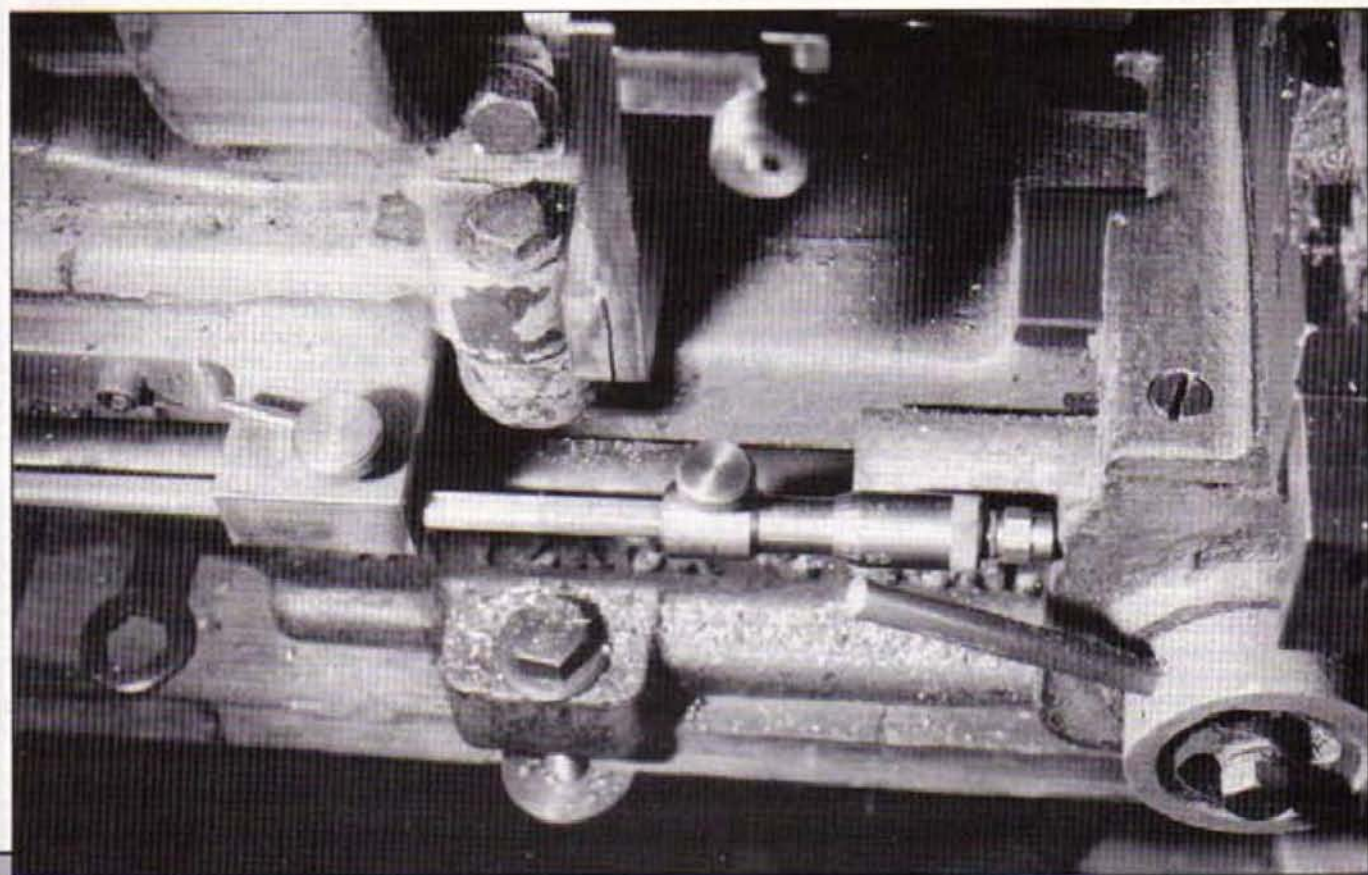
It is assumed that the leadscrew and its bearings are in good condition, likewise the headstock spindle. It is worthwhile checking these over before you start. I never use my leadscrew for normal traversing operations and, although the machine is about 30 years old, it will still cut an accurate thread.

Take a piece of $\frac{1}{8}$ in. dia. mild steel and with about $1\frac{1}{2}$ in. projecting from the 3 jaw chuck, face and centre the end with a small centre drill. Support the end with the tailstock centre then turn the end down to 0.187 in. for a distance of 0.781 in. Reduce the next $\frac{1}{8}$ in. down to 0.350 in. Grind a knife tool for turning towards the tailstock and plunge this in close to the chuck. Traverse it to the right until the 0.350 in. dia. is reduced to a collar 0.047 in. wide. A good sharp corner is required at the shoulder and the face should have a good finish and be square to the axis. Continue this in a series of cuts until the diameter is reduced to 0.187 in. and it is at least $\frac{1}{8}$ in. long from the

collar. Now a $\frac{1}{8}$ in. wide parting tool is needed to produce the undercuts shown on the drawing and one for the screwcutting tool to run into at the chuck end of the screw. All these undercuts should be 0.015 in. deep. This depth can be obtained by using the index collar on the cross slide of the lathe.

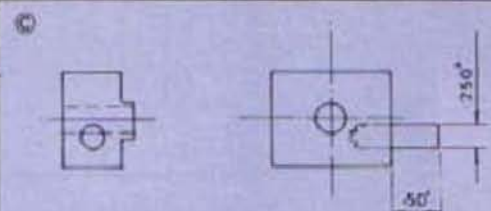
The next operation is to set the screwcutting train. Most lathes have full instructions for this, but for those without this luxury, a total reduction 5-1 is required between an 8 TPI leadscrew and the work. A compound train with 20 as the first driver, onto a 40 driven wheel with the second 20 as its mate (most lathes have two 20 tooth wheels) driving a 50 tooth wheel on the leadscrew will give the correct result. A screwcutting tool must be ground to an included angle of 55 deg. On a thread as fine as this, it is necessary only to just stone the sharp edge of the front of the tool. It is best done with two or three light strokes on an Arkansas stone. The tool must be set at centre height or very slightly below. The top slide must be swung 27 $\frac{1}{2}$ deg. to the right with respect to the cross slide or 62 $\frac{1}{2}$ deg. with respect to the lathe centreline. The tool tip must be set with a screwcutting gauge so that the axis of the thread form is square to the axis of the screw.

Before making the first cut there are one or two checks and settings to be made. First check that you can get the tool to traverse the full length of the required thread without fouling the chuck jaws against the slides, toolholder etc. Next, with the tool well clear of work, check that the saddle moves towards the headstock when you engage the half nuts and check that the threading dial is properly engaged with the leadscrew and is firmly tightened. Engage back gear and the lowest speed of the belt drive if you are a novice.



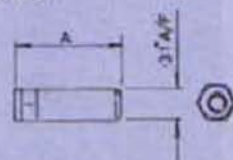
The depth of the thread is very critical if a good fit in the nut is to be achieved. In the first instance, this is going to be controlled by the index collars on the cross slide and top slide. Advance the tool with the top slide a little to eliminate the backlash then advance the tool with the cross slide until it just touches the work. I find that this is best done using an eyeglass and a piece of white paper behind the work, so that you have a clear silhouette of the situation. With the tool in this position, set both index collars to zero. This is the starting position, a full thread will be cut when the top slide has been advanced by $\frac{1}{4}$ times the depth of

little. The nut should now be a good fit, i.e. no slack, but free running. If it is still tight, try stoning the top face of the tool and take another pass along to thread without advancing the tool. If it is still tight, further 0.0005 in. cuts are necessary, followed by light use of the emery paper until the desired result is obtained. Note the number on the top slide index that produces the desired result on the long thread and then go one or two thou deeper than this on the short thread. Part the completed screw off at a little more than 0.515 in. from the collar. Wrap some brass strip around the long thread to avoid damaging it with the chuck



SPECIAL STOP BLOCKS FOR MILLING M/C OR CUTTER GRINDER

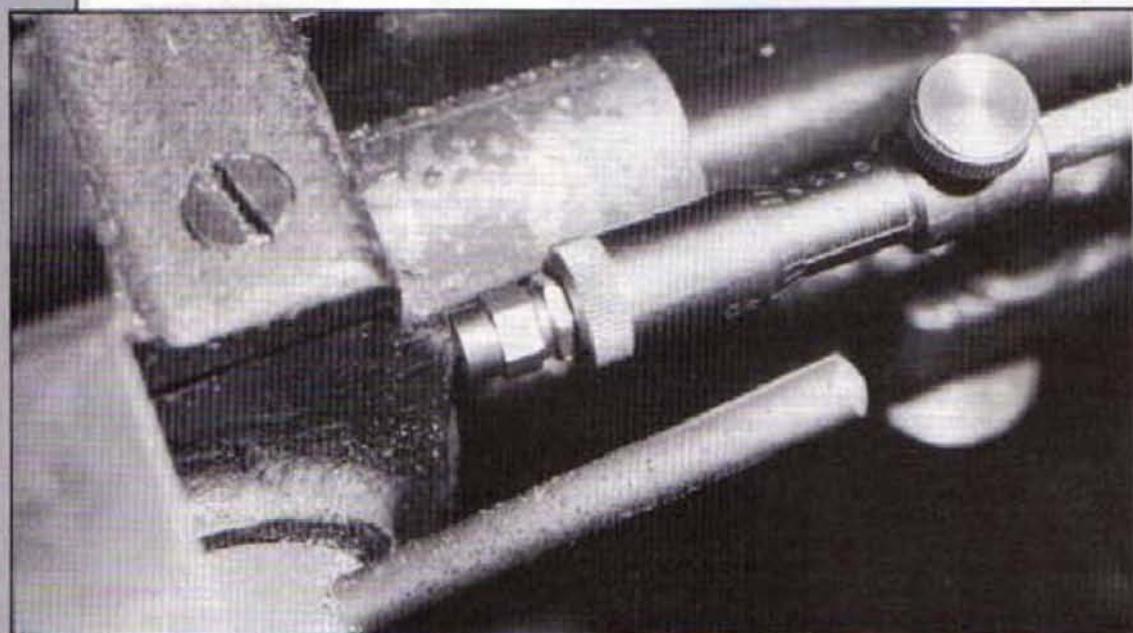
10FF AS SHOWN 10FF OPPOSITE HAND IF REQUIRED



DIM A = LENGTH OF SMALLEST CAP NUT PLUS .5000, 1.0000, 1.5000, ETC.

EXTENDED CAP NUTS FOR MICROMETER HEAD

A close-up of the cleared areas of the carriage used as the reference face for the micrometer stop.



the thread. The sketch shows the simple trigonometry and arithmetic supporting this.

Withdraw the tool from the work half a turn on the cross slide and move the lathe saddle until the tool tip is about $\frac{1}{4}$ in. to the right of the screw. Now advance the top slide to 0.005 in. beyond the zero and engage the leadscrew when a numbered index on the threading dial is, as nearly as possible, in line with the reference mark. Very rarely do these marks coincide exactly when the half nuts are fully engaged, but as long as you remember their relative positions, a clean engagement can be made at each cut. The tool will now travel along the work making a whisker of swarf as it goes. As it gets near to the end, stand-by to disengage the leadscrew nuts and simultaneously withdraw the tool using the cross slide. Do this as the tool tip passes into the undercut. If you have a thread pitch gauge, just check that you have in fact cut a 40 TPI thread. It is just possible that you have picked the wrong change wheel and at this stage the work is still "rescuable". If all is correct, take another 0.005 in. cut using a little cutting oil, followed by two more at 0.003 in. The reading on the top slide should now be 16 and you can try the nut on the thread. It is unlikely to go on unless you have been a bit heavy-handed in establishing the starting position of the tool. Take a series of 0.0005 in. cuts until the nut just starts to go on to the screw with a little bit of interference. Take a piece of fine emery paper and, with the lathe rotating, run it along the tops of the threads to remove the burr and round off the crests a

little. The nut should now be a good fit, i.e. no slack, but free running. If it is still tight, try stoning the top face of the tool and take another pass along to thread without advancing the tool. If it is still tight, further 0.0005 in. cuts are necessary, followed by light use of the emery paper until the desired result is obtained. Note the number on the top slide index that produces the desired result on the long thread and then go one or two thou deeper than this on the short thread. Part the completed screw off at a little more than 0.515 in. from the collar. Wrap some brass strip around the long thread to avoid damaging it with the chuck

jaws. Then face the end down to size. Finally, a cut with a junior hacksaw is made across one end of the screw as per the drawing.

The lock nut and cap nut are so straightforward that further description is unnecessary.

Numbering the divisions

Stamping the numbers on the nut and thimble can make or mar the look of the finished article, so some form of jiggling is strongly recommended. I have a block with a slot to take the stamps milled in one face. The other faces have holes drilled and tapped in them for bolting to angle plates etc. to suit the item being stamped. The sketch shows possible methods of setting up the stamping operations. The final details will be determined by your own equipment. If you decide to do it freehand, take great care, and have plenty of time available - doing it in a hurry will almost certainly give disappointing results. It is not necessary to stamp every number on the nut. The 0, 2 and 4 are sufficient. The 5 comes quite close to the shoulder and this makes it difficult to get a neat result. When stamping the thimble, make sure that the numbers are in the right order, i.e. rising as the screw is turned clockwise. The bruising that occurs around the characters can be smoothed down using a fine needle file followed by a rub with emery cloth.

Assembly of the parts needs no explanation except, perhaps, locking the thimble in the correct position on the screw. If you run the screw into the nut to about

half its length, then place the thimble over the screw and hold it lightly against the collar with the zero in line with the reference line on the nut, you can rotate the projecting end of the screw until the end of the thimble aligns with any line on the nut. The locknut can then be run against the thimble and locked tightly. The cap nut needs only to be finger tight as it is intended to be one of a small series, which will increase the range of the stop, therefore it must be easily removable.

Further uses for the tool

There are two further uses to which the micrometer head can be put. The first, as mentioned at the beginning of this article, is as a bed stop for a milling machine or cutter grinder. For this, all that is required is a $\frac{1}{4}$ in. dia. peg $\frac{1}{4}$ in. long projecting from the standard stop. The sketch shows the general idea, specific dimensions being dependent upon the machine.

The second is for use as an inside micrometer. The cap nut will need to be replaced by another having a domed end, and a series of length rods will be required, also with one end domed. The smallest diameter that can conveniently be measured is $\frac{1}{8}$ in.

This second use is only a makeshift one because the numbering on the nut and thimble are both the wrong way round. If the head is likely to be used a great deal as an inside micrometer, it is, of course, quite possible to stamp a second series of numbers on the thimble in reverse sequence, which would considerably reduce the chances of misreading.

TORQUE ABOUT FLEA POWER

The author of this delightful article spent his life as a professional model engineer making models for commercial firms, usually as a forerunner to the firms producing the full-sized prototype. Inevitably there were trials and tribulations, with panic stations being reached on more than one occasion. Here we read a light-hearted account of an experiment in getting a suitable bearing arrangement; apart from the account of the work involved readers may well find an interest in the methods finally used for the project.

Fig. 1.



Hero proposed a combined boiler and steam-driven 'engine'. According to his theory and if friction could be minimised, his 'engine' should rotate due to reaction from the two steam jets.

Hero was a brainy Greek. In 50 AD brainy Greeks had time to rest chin in hand and ponder. Having watched liquids and gases escape from containers, Hero noticed they appeared to repel or react, as if exerting a push; escaping matter going one way, the pipe or container from which it escaped tending to go the other.

He proposed a design for a primitive steam-driven device, the *Aeolipile*, a basic reaction turbine generally known as Hero's Engine. If his theory proved correct and if friction could be minimised, his device should rotate due to reaction developed by two fine steam jets.

But, as the Science Museum in London know only too well, theory is one thing, making it work is another. When they built an engine to Hero's scheme, it refused to perform. That was the situation facing us when, as professional model engineers, we received an order from an overseas university calling for:-

- Ten Working models of Hero's Reaction Turbine to be delivered in twelve weeks.
- Little or no time for exploratory trials or second thoughts. It was do or die.

But where to start in our race against time? The Science Museum had nothing to offer and knew of no other museum in a position to help. We were as much on our

own as Hero was in 50 AD, except Hero had all the time in the world. We faced a deadline, a budget price and serious repercussions if we failed on either count.

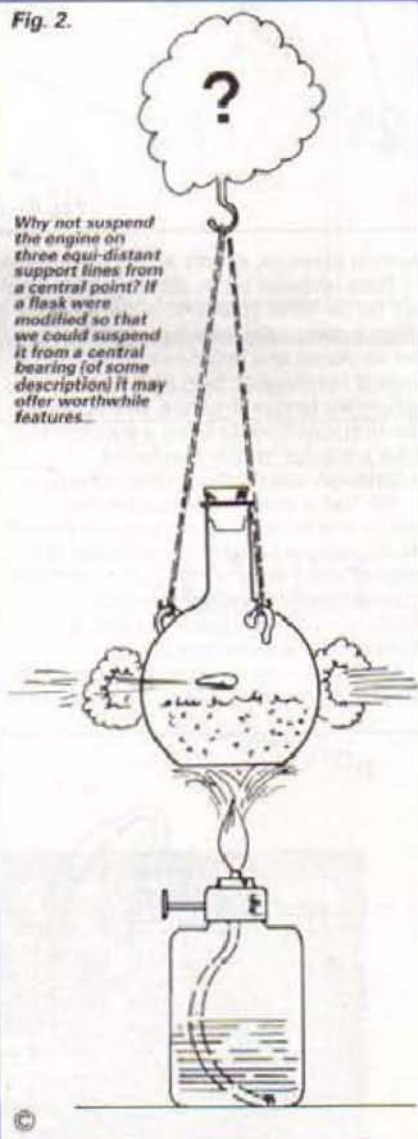
From experience we knew that when power and speed are minimal and loading is heavy, ballbearings need treating with caution, stiction being a critical factor. (Even jewelled bearings of aneroid barometers require releasing by gentle taps prior to readings).

At best, two wispy jets offered flea power in terms of stiction beating a turning moment.

A horizontal axis demanded precise balance, so we considered a vertical axis and recognised that even if we could keep it upright, bearing problems were aggravated; one pivot supporting all. We aimed to reduce, not increase, stictionitis.

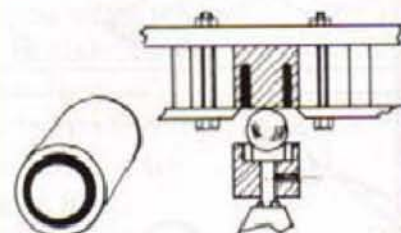
We churned things over - then turned things over. Why not suspend it like a bowl-shaped lampshade, using three equidistant support lines from a central point? It triggered promising lines of thought. Light bulbs are shaped similar to laboratory flasks. If a flask were modified so that it could be suspended from a central bearing (of some description) it would offer worthwhile features. Being glass, two fine-drawn glass tube nozzles could be bent

Fig. 2.



Why not suspend the engine on three equidistant support lines from a central point? If a flask were modified so that we could suspend it from a central bearing (of some description) it may offer worthwhile features...

A 1 in. diameter hardened-steel ball (spun to identical speeds by means of a gun-drill fitted with a tubular plastic 'clutch') showed constant rundown times on either a glass panel or when attracted to the hardened and polished lower face of a vertical bar-magnet.



Details of the Eclipse single ended cylindrical magnet.

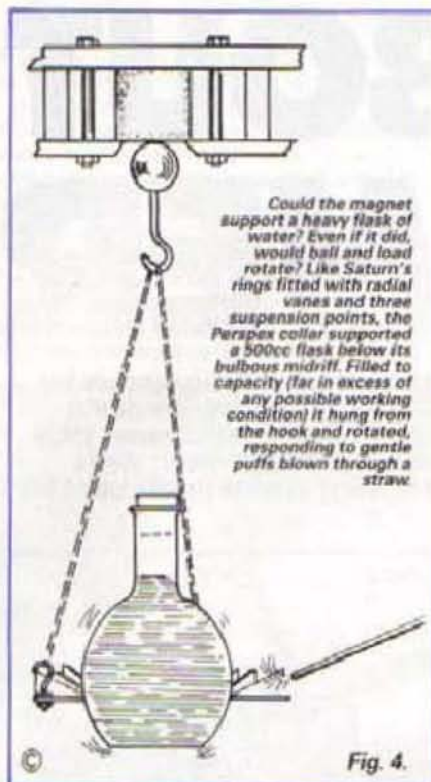


A thin Perspex collar fitted with radial vanes and three equidistant suspension hooks.

Fig. 3.

and attached at diametrically opposite points on its largest diameter, its bulbous midriff. Loaded with water to a level below the jets, plugged by a standard rubber stopper and heated from below, it would be a self-contained boiler-cum-reaction turbine.

Practicable, provided we could dream-up a bearing. Further pondering led to a possible solution; suspend it from a magnet. Adding a load would reduce



bearing pressure, exactly what we required.

Tests revealed a 1 in. dia. hardened-steel ball (ex-ballrace) spun with equal ease on either a glass panel or when attracted to the hardened and polished lower end of a vertical bar-magnet, held aloft by a temporary bridge structure. (We achieved identical spin speeds using a gun-drill to drive a tubular 'clutch' and found surprisingly constant run-down times).

We had a welcome (unsuspected) bonus. In a most satisfying manner the ball always adopted a central position on the magnet's end-face, resisting all reasonable attempts to deflect it; an excellent discovery although, given thought, it should have been expected.

Could the magnet support a heavy flask of water? Even if it did, would ball and load

rotate?

Securing a hook to the ball and revolving various weighty objects showed our magnetic bearing exceeded expectations. Heady stuff; hopes ran high.

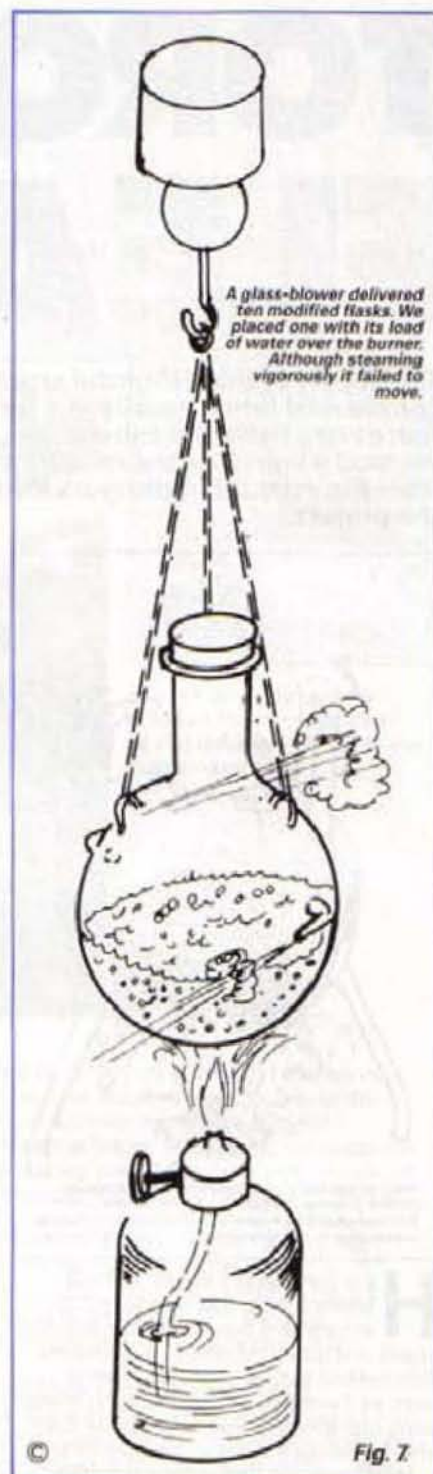
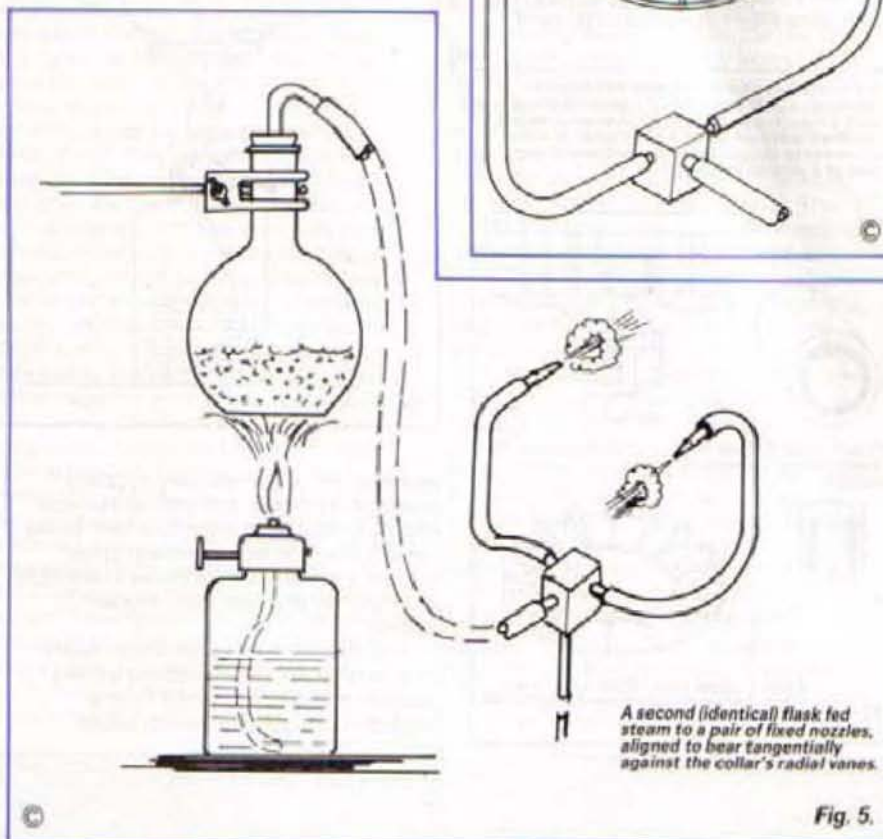
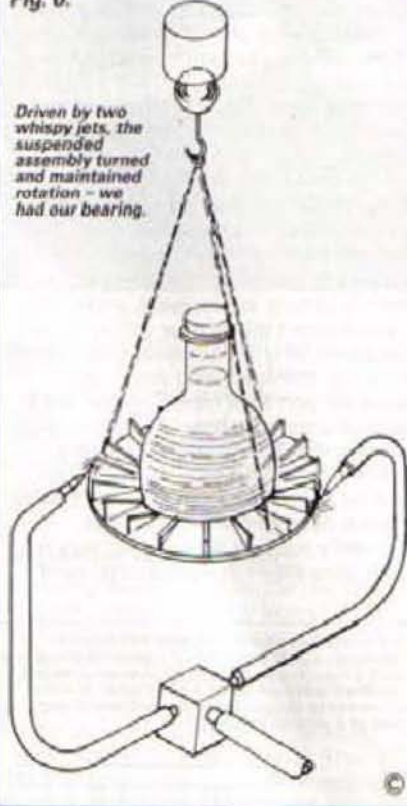
Like Saturn's rings fitted with radial vanes and three equi-distant suspension lines, a thin Perspex collar supported a 500 cc flask below its bulbous midriff. Filled to capacity (far in excess of any possible working condition) the flask hung from the hook and rotated in response to gentle puffs blown through a straw.

Would two delicate steam jets turn it? Hurriedly we rigged a second (identical) flask which fed steam to a pair of fixed nozzles, both aligned to bear tangentially against the collar's radial vanes. Our pulse rates increased as, driven by two wispy jets, the suspended assembly turned and maintained rotation – admittedly by impulse – not reaction, but we had our bearing.

Progress indeed.

A local glassblower set about modifying ten flasks to our sketch (swallowing a hefty chunk of our remaining time in the

Fig. 6.



QUICK TIP

Sometimes it is necessary to decide what the thread of a screw is and no gauge of suitable pitch is available. Keep a candle in the workshop. Break off a piece and warm it in the hand until soft, then press it on the thread, a clear impression will be left and the pitch can be measured from this. Plasticine will also work but if you're not careful it rapidly distorts, giving a false reading.

process), while we made the pattern and ordered ten aluminium castings to grip the magnets and support the flasks.

In due course, our first *Hero* was ready for trial. Loaded with hot water to reduce a nail biting wait, *Hero* hung above a spirit burner. (Our version of today's countdown to a rocket launch). Two wispy curls of steam appeared, jets developed – and *Hero* refused to budge; even remaining so when boiling vigorously with both nozzles freely jetting steam. A nudge and he moved – and stopped.

Jet-lag?

Emergency treatment? You name it, we tried it. (A drop of clock-oil caused drag effects - we couldn't win).

It just wasn't OUR day, but our resident Gremlin, Sonya Ann Yetsofpa, was enjoying every minute.

Success so close and delivery pressing, we slept on it, hoping to dream-up a solution.

Greeks used logic – it may work for us – so we resorted to logic; if two flat surfaces wring together in one extreme, the opposite – two curved surfaces – should minimise the effect.

Inserting an identical second ball would reduce pivot-point contact to that of two hardened and polished curved surfaces; truly minimal friction.

Worth trying...

With a second ball in place, we applied heat and waited. Wispy steam appeared. Seconds later Hero moved, slowly gained speed and stabilised around 40 rpm.

We ceased biting our nails, delivered all ten on time and to Hero's relief, proved him right!

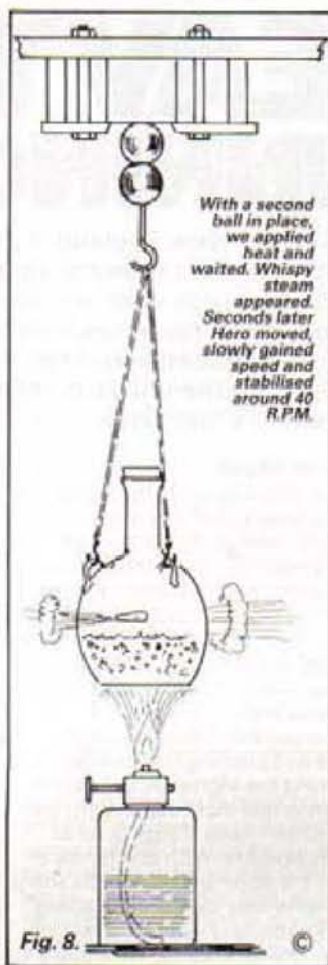


Fig. 8

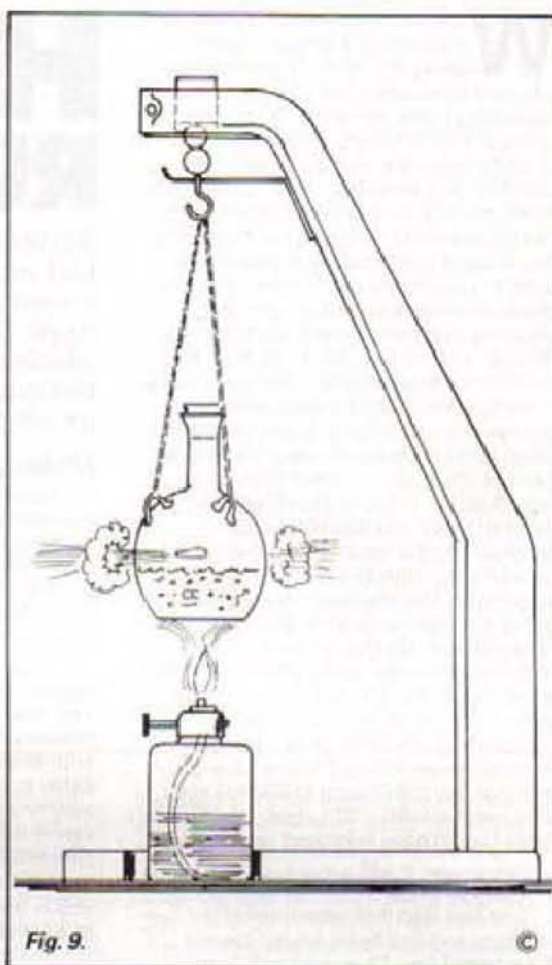


Fig. 9

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When turning between centres or supporting a long workpiece using the tailstock centre, have you ever been rewarded by a high pitched squeaking noise and smoke rising from the tailstock end of the job; followed, if you ignored these dire signals, by an unpleasant graunching noise, heralding the destruction of your tailstock centre? If this has happened to you, as it has happened to me, in spite of lubricating the centre, in spite of keeping the workpiece cool with plenty of soluble oil and in spite of checking that things aren't too tight (though it is not possible to do so in the middle of a finishing cut), then you need a running centre. Good quality running centres are not cheap and they cannot be relied upon to be as true as a brand new fixed centre in an unscored socket. I was put off by the price, so I decided to try to make my own and was pleasantly surprised by the result obtainable simply by taking my time and trying to be systematic. The maximum permissible run out of the internal taper of the main spindle of my lathe is 0.01mm (0.0004in.) at the end of the spindle nose and 0.015mm (0.0006in.) of run out of the live centre is permitted though the actual figures on test are half of these values. My attempt at making a running centre resulted in one having a total run out of 0.015mm (0.0006in.) and I dare say that with a little more attention to detail I could have improved on this figure.

The bearings

The first step is to obtain suitable bearings and this really means buying them brand new. Ones stripped from scrapped machines may do for less critical applications, but not for this duty. I aimed for the maximum bore with the minimum external diameter, keeping in mind that the external diameter is what really limits the usefulness of the centre. Too big and it fouls the toolpost; too small and it cannot withstand the load from a combination of cutting loads and thrust from an expanding workpiece. While in theory this is the only application where a semi-thrust bearing can be used without preload, I decided not to copy commercial practice but stick with the devil I knew and settled for a pair of opposed, preloaded taper-roller bearings of 17mm bore, 40mm outside diameter and 12.4mm thickness (total cost NZ\$24 or about £8). I then designed the centre around the bearings. As I wanted sometimes to be able to support tubing with the centre, I decided to reverse normal practice and have the inner rings secured to the shank, with the preload applied to the outer rings and the whole body of the centre rotating. This way I could have a running centre able to accept tubing up to 50mm bore. As my lathe tailstock has a No. 3 Morse Taper socket, I made mine to fit, but the principles are the same whatever size socket your lathe has and you can modify the measurements to fit whatever bearings you choose to use.

HEAVY DUTY RUNNING CENTRE

Bill Morris from New Zealand is an experienced model engineer. Like most he prefers to make equipment when possible, thus giving a saving in money as well as ensuring accuracy in the equipment itself. This article describes a running centre which, although a precision instrument, is not too difficult to make. Although designed for a lathe with a number three Morse Taper the tool can be adapted for other sizes

Making the taper

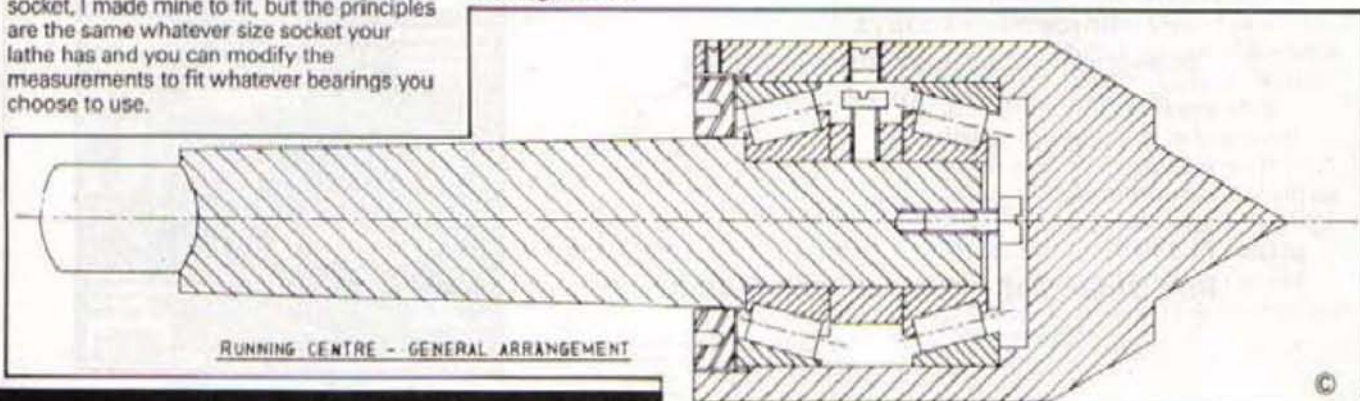
I began by chucking a 135 mm length of 25 mm round steel bar of uncertain parentage, and carefully faced the end. After rechucking with 100mm projecting from the jaws the next operation was to drill a centre hole with a new, and hopefully true, centre drill. Beginners may not realise the reason for rechucking; I wanted the centre hole running as true as possible and had I rechucked after drilling would possibly have put the drilling off centre, with strange and puzzling results when it came to turning the Morse Taper. I have a very tiny boring tool that I use to skim the centre hole when I need things to be as concentric as possible. With one centre in the tailstock, the other is held with its sharp end in the centre hole just formed, acting as a female centre, and its blunt end supported by the tailstock centre (Figure 1). If you use your centres as centre punches, you cannot do this, as you will have burred the female centre in the narrow end and the business end won't be much good either. A dial test indicator is clamped in the toolpost with its plunger exactly on centre height and the top slide set over to approximately the correct angle to follow the taper of the imprisoned centre. One and a half degrees is quite a good starting

point. Wind the top slide back as far as it will go with the plunger of the dial test indicator on the narrow end and set the indicator to zero using the cross slide. Lock the saddle and wind the top slide as far as it will go the other way. Unless you are exceptionally lucky, the indicator will no longer read zero, loosen whatever arrangement binds the topslide to the cross slide and gently tap it around until the indicator reads the same, but on the other side of zero. Of course, as soon as you tighten the top slide, the reading changes, but by carefully repeating the process; (it is worth spending a few minutes on getting it right), you will eventually have the angle of the topslide set to that of your chosen Morse taper. Remove the centre used to establish the angle, without removing the chucked steel, support this with the centre - not forgetting lubrication.

Once you have the correct angle, then the actual turning is relatively easy if your lathe is in good condition, your tailstock accurately aligned with the lathe axis and your tools sharp and dead on centre height. If your tail centre is looking sorry for itself, you don't have to have a toolpost grinder to true it up in the headstock spindle; you can soften the point by heating, take a skim and reharden or, much easier and quicker, take



A captive centre - held between a false female centre at the chuck end, and a tailstock centre. The D.T.I. is used, as explained in the text to establish the correct angle for the topslide where the tool will be mounted to turn the body of the running centre.



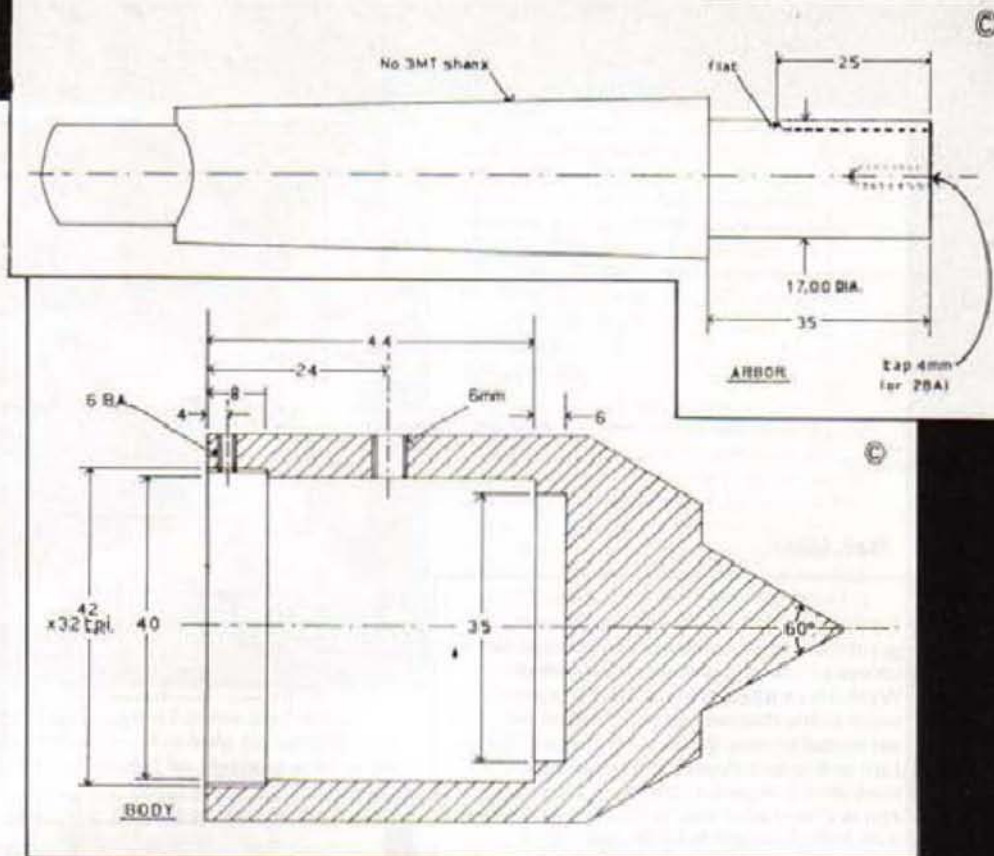
a thin skim with a nice sharp carbide tipped tool. Bring up the tail centre to support the workpiece, turn down a suitable length for the tang and carefully produce the taper, aiming for the best finish you can manage. The finish produced using the top-slide always seems to be poorer than usual because it is very difficult to get uniform feed and there is a tendency to disturb the settings of the other slides as one twists the handle. The saddle should, of course, be locked for top-slide operations and it is a good idea to lock the cross slide between cuts too. Use two hands to turn the handle and as you begin to run out of twist with one hand, smoothly transfer to the other so the feed is as uniform as possible. When the taper is about half formed, smear a little engineers' blue (NOT marking-out blue) on the inside of a socket of appropriate size and try it for fit. You should find a uniform smear of blue on the workpiece and if you don't, having set up the taper angle with a dial test indicator, you are unlikely to achieve it by haphazard tapping round of the top slide at this stage. An imperfectly aligned tailstock centre may displace the workpiece from the centre line even if it is held in a chuck, so it is worth trying a fine cut with the end unsupported to see if matters improve. Continue until the taper is to length. Do not be tempted to finish with emery paper. It will not improve a poor fit, and there is a danger of catching a sleeve in the revolving work or chuck.

The bearing housing

Remove the workpiece and then the chuck, clean out the spindle taper very carefully. Clean your nice new taper and push it into the spindle nose ready for the next operation which is to face, drill and tap the projecting parallel portion 2 BA or similar. Turning it down to the correct size for the bore of the bearings is not as easy for the relative beginner as it might seem. The aim is to arrive at a light interference or stiff push fit. To do this, it helps to start with the part a little over-length and, once near finished diameter, to cut a small shoulder and try until the inner ring of one of the bearings will just fit with a show of reluctance. If you get things too small, it is a simple matter to turn another little shoulder until you get it just right. When you have it right, turn the rest of the length to size, face the trial bits and lightly chamfer the edge. File a flat on the parallel portion for about two thirds of its length and remove any burrs this may cause. All being well, you now have a completed arbor with a Morse taper shank of your choice. An alternative would be to buy a drill arbor and turn down the Jarno or Jacobs taper on the end to make a parallel portion. However, if the end is hardened, and one I bought to try was, you will have to use a carbide tool, but the taper can be relied upon to be well finished and true.

The spacer

Chuck a piece of steel of the same diameter as the outside diameter of the inner rings of the ballraces and just over your chosen length for the spacer. Face it, start a hole with a centre drill and follow through with a drill about 1mm less than the diameter of the parallel portion of the arbor. Then bore it carefully so that it forms an easy running fit on the arbor and take a final fine facing cut. Drill and tap for a set screw, about 2 BA, replace the arbor in the spindle taper (which you will of course



have remembered to clean meticulously) and fix the spacer on to it using the set screw against the filed flat so that you can face the unmachined end to the correct length. With any luck, both ends will then be parallel to each other. Some people may prefer to avoid this last operation by parting off the spacer from a longer workpiece; O.K. if they are confident they can part off without the parting blade wandering all over the place and resulting in something that may or may not be to size and may or may not have flat ends.

The centre

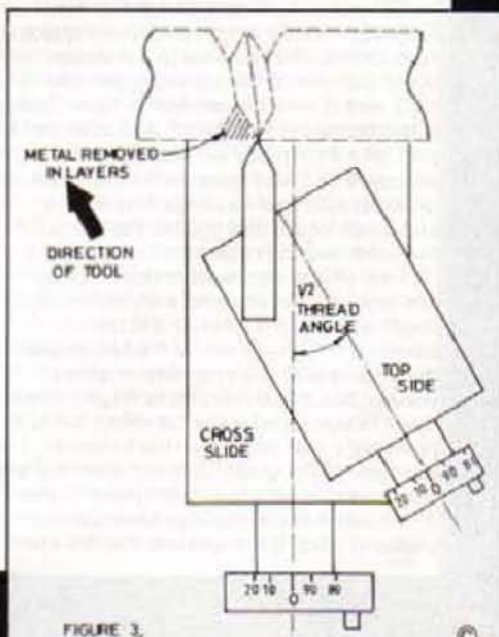
The amateur worker cannot really harden the business end of the centre and then finish grind it inside and out and there is no real advantage in having a hardened running centre anyway. While the material used could with advantage be tougher, free-cutting mild steel for the body of the centre makes life easier and I am all for that. Use a piece 50 mm in diameter and about 110 mm long. Chuck it with about half projecting from the chuck jaws and with the top slide set over to 30 deg. rough turn the nose to whatever combination of cones and segments of cones that take your fancy. Fig. 2 shows what took mine. Then turn it round in the chuck and turn down about 10 mm to an outside diameter suitable for the rear retaining cover and chamfer at 45 deg. for about 1 mm. Choose a diameter which when screwed something like 32 TPI will have a core diameter about 1 mm greater than the outside diameter of the outer bearing rings. If you are wondering why I have mixed metric and Imperial here, it's because everything on my lathe is metric, except the leadscrew which is 8 TPI with a threading indicator to match, so it's much easier to cut Imperial threads.

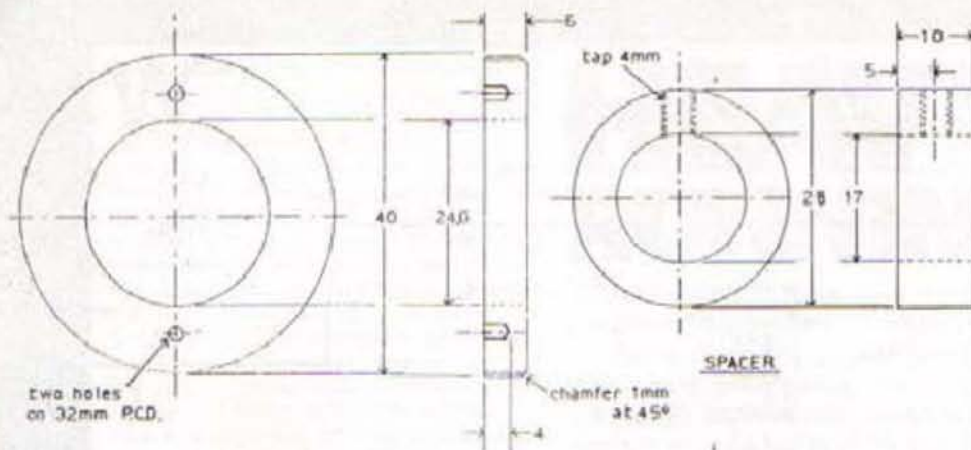
For screwcutting, inside and out, I always set over the topslide, swivelling it through 60 deg. from its normal position parallel to the lathe axis for metric and American threads and 90-275 deg. -62.5 deg. for Whitworth threads. The method gives a superior finish to the thread

because the front edge of the tool does all the cutting while the point is fed in a line along the rear flank of the thread cleaning up the flank as it goes. Fig. 3 makes this clear. The tool can be given top rake and then it will cut very freely. I am told that they no longer teach the method at the local Polytechnic because the maths involved in calculating the amount of cut to put on with the topslide is felt to be too hard. All you have to do is divide the depth of the thread by the Cosine of half the thread angle. So, for 32 TPI, it is $0.020/\cos 275 \text{ deg.} = 0.020/0.866 = 0.023 \text{ in.}$ with next to no difference for 60 deg. threadform. Since the books and articles I've read tend to gloss over exactly what to do I will try to improve on their accounts. Experienced screwcutters can skip the next paragraph.

Screwcutting

You have your top slide set over to the chosen angle and then set up your screwcutting tool dead on centre height and square to the axis of the workpiece. A screwcutting gauge is almost indispensable





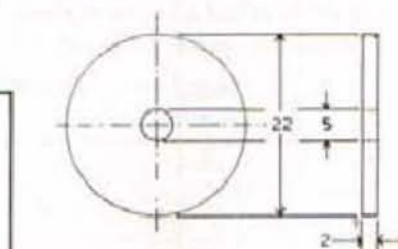
REAR COVER

for this (Fig. 4) and you will need one to grind the tool to the correct angle anyway unless you have a proper cutter grinder. Wind the cross slide in until the tool just touches the diameter to be threaded and set its dial to zero. Wind out the top slide a turn or two to take up the backlash and then wind it in until it just touches the work and set the dial to zero. Move the saddle over the full length to be threaded to check that nothing fouls the chuck, set up the screwcutting gears, check that you have done so correctly and put the lathe into lowest back gear. Put on a few thousandths of an inch cut with the top slide and, with one hand on the cross-slide handle ready to take off the cut, engage the clasp nut. When you reach the end of the threaded length, simultaneously disengage the clasp nut and take off the cut. Wind the saddle back to the beginning of the cut, set the cross-slide to zero again, put on a little more cut with the top-slide and repeat the process, each time setting the cross slide to zero, until you have reached the correct depth of cut as indicated by the top slide dial. The process is made much less critical if you cut a small groove for the tool to run into at the end of the cut as all you have to do is disengage the clasp nut as it does so and can retract the cross slide at your leisure. If the pitch of the thread you choose is exactly divisible by the pitch of your leadscrew, the clasp nut can be engaged at any position. If it is not, you will have to use a threading indicator if you have one or leave the clasp nut engaged and wind the saddle back by reversing the lathe.

When you have screwcut the 10 mm length previously turned on the workpiece, face, centre, drill and bore to a diameter about 0.25 mm (0.010 in.) larger than the thick end of your chosen Morse taper. Take a fine facing cut to finish off and carefully part off a 6 mm (0.24 in.) slice. Drill two shallow 2 or 3 mm holes on the back face on a diameter and you have finished the end cover, which also applies the preload to the outer bearing rings.

Face off any remnants of the previous operation on the workpiece and drill to a depth equal to the width of the two bearings plus the length of the spacer plus the thickness of the inner ring-retaining washer plus a few millimetres for the screw head. Rough bore for the full depth out to a diameter a little more than the inner diameter of the outer rings and open out to the outer diameter to a depth equal to that of the width of the bearings plus spacer plus end cover. It is important that the outer

SPACER

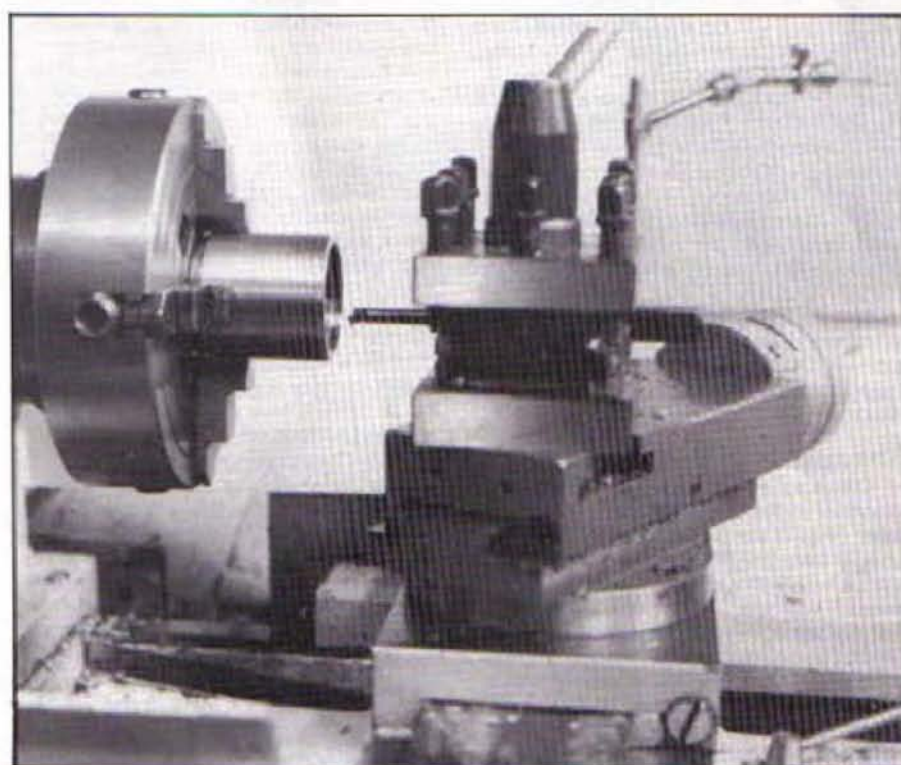


WASHER



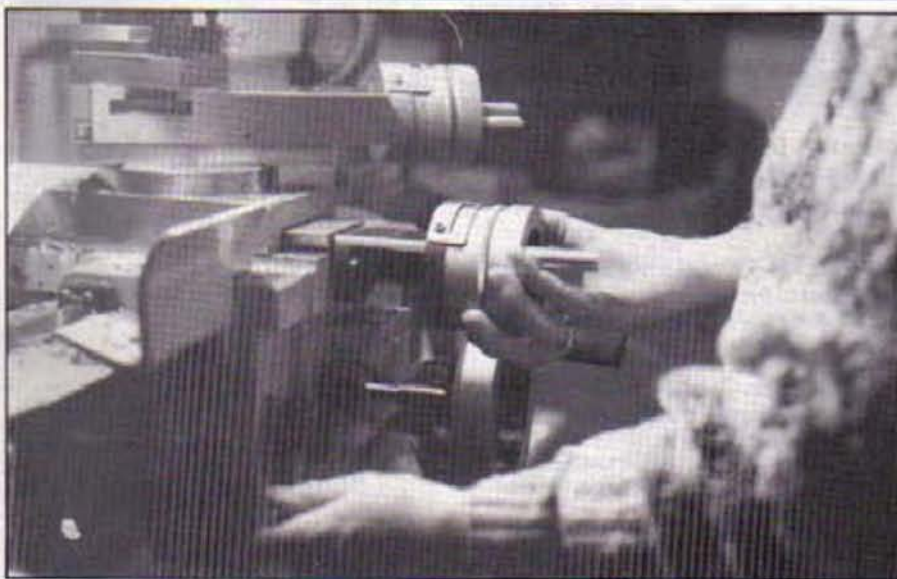
Above: With the top slide set over to half thread angle the tool is positioned by the use of the threading gauge.

Below: The internal screwcutting operation on the body of the centre, viewed here from the rear of the lathe.



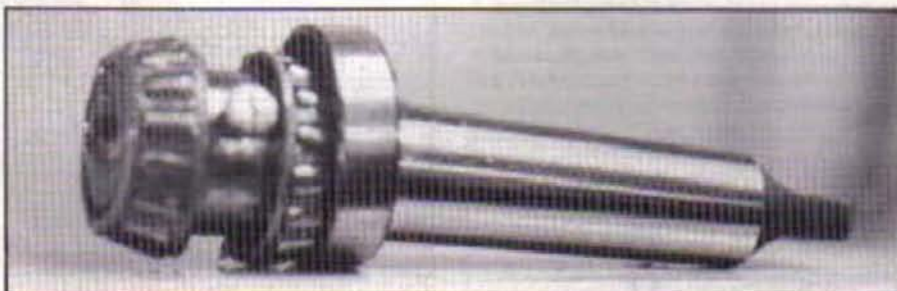
rings should fit as closely as possible without any shake, but should be able to slide in the bore, albeit with a bit of pressure. You have 8 mm of grace for cutting and trying for the finishing cut as the first 8 mm is going to be threaded for the rear cover. Use the thickest boring bar you can manage with a sharp, well-honed tool, so that you get the best finish possible and when you put on a cut, there is a minimum of spring. When you think you have got things right on the first 8 mm, take your finished cut to full depth and hope for the best. Stop the lathe to withdraw the tool between cuts as most lathes with a little wear cut more as the tool moves towards the tailstock. Usually an outer ring used as a gauge will only go in for the 8 mm, so take another cut at exactly the same setting to "work out the spring", and keep going until the ring enters and all is well or the tool stops cutting and the ring won't enter, in which case all is not well. In this event, try a cut at the same setting but with the tool moving out of the hole towards the tailstock. If this doesn't work, you can try the desperate expedient of wrapping fine, worn emery paper around a mandrel and using it as a crude lap with the lathe running at high speed, but you may lose both parallelism and concentricity in an area where it really matters. Finish off by facing the shoulder for the front inner ring.

Try a ring to make sure it will go to full depth, but don't force it or you may never get it out again. I made up an extractor shaped like a capital Greek omega (Ω) from a wire coat hanger. Baler twine and number 8 fencing wire are the standard material for improvisation in New Zealand but I found coat hanger wire works very well for the purpose, living as I do in a city, where fencing wire is not easily to hand. Now you

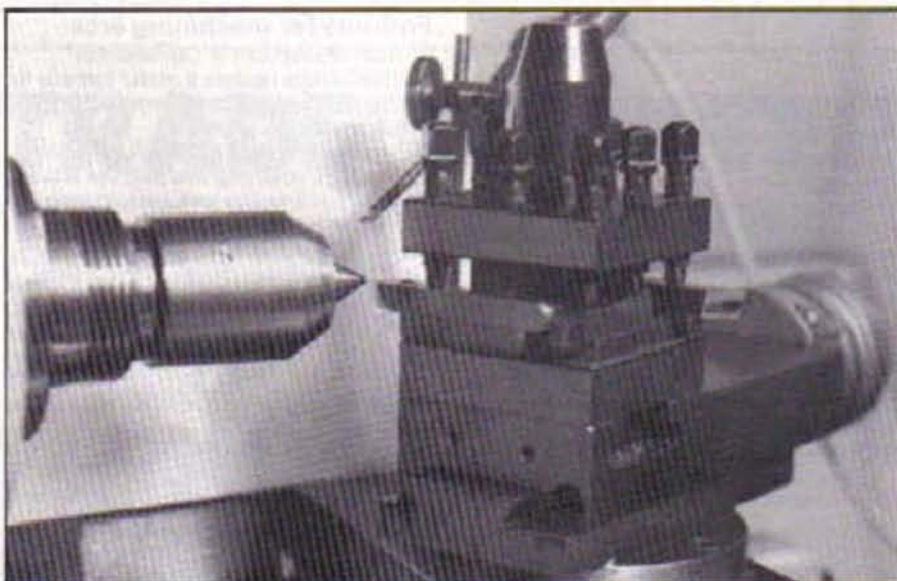


Above: The operator ready to disengage the half-nuts and whip the tool out of engagement during the external screwcutting operation. It should be noted that this is a posed shot, with the author's wife acting as model for the purposes of the photograph.

Below: The centre, seen here partially assembled, the locking screw for the bearing spacer is in position.



Below: Turning the nose of the running centre to the author's fancied shape, it can be used as a pipe centre on the larger diameter as well as its more normal use. This final operation ensures maximum concentricity, the bearings are locked and the centre is revolving in the machined socket in the lathe mandrel.



can open out the first 8 mm of the bore to the core diameter of the end cover and screwcut it until the cover fits easily. This easy fit ensures that the threads bear on the flanks and squareness is maintained. To set over the top-slide for internal screw cutting, you have to rotate the slide anti-clockwise. Fig. 5 shows the set-up. As there isn't really room for a run-out groove, you have to be really slick at operating the cross

slide and clasp nut, but as the lathe is turning slowly and the thread is a fine one, it is not too difficult after a little practice. There is a lot to be said for cutting these fine short threads that run into a shoulder by turning the lathe by hand. That way, you have time to think and avoid the disaster of turning the cross slide the wrong way at the end of the cut. By placing the hand upside-down underneath the handle it

makes it less likely that you will go the wrong way. Fig. 6 shows what I mean. For internal screwcutting, you have your forearm fully rotated in the opposite direction to that shown, so you can only wind in at the end of the cut (and no, I don't wear fancy jumpers and rings when I'm in the workshop. My wife was kind enough to pose while I took the photograph).

Assembly

When you are satisfied with your turning and screwcutting, drill and tap the holes for the two grub screws. The smaller one is obviously for a little brass screw to lock the rear cover and the larger one for stopping the grease flying out, but this latter also has another very important use which will become clear. You now have to clean up all the bits, including the bearing that you used as a gauge when turning the arbor and body. Clean white spirit is the correct stuff to use for this and don't skimp on it, especially when cleaning the bearing. Allow everything to dry on a piece of kitchen tissue and then you are ready to assemble. The easiest way is to grip the arbor in the vice firmly by the tang and fit the inner rings with spacer between. It is annoying to assemble the bearings the wrong way round, so reflect a little and save some time. Line up the tapped hole in the spacer with the flat on the arbor but do not tighten the screw at this stage. Fit the retaining washer and screw and tighten the latter hard. Now you can tighten the spacer screw. This screw must be of such a length that its head projects just enough not to foul the inside of the body when everything is assembled (Fig. 7). Put a smear of oil on the inside of the body, insert the front outer ring and push it down onto its shoulder. If everything is of the correct size you may find that the ring has a pronounced tendency to rock slightly and jam in the hole until the full length has entered. Then it should slide in with firm resistance. Smear grease generously over the rollers with a clean finger and put a generous amount inside the body (but don't pack it full). Clamp the body in the vice, open end uppermost, insert the arbor and bearings and wheel the rear outer ring into its seat, followed by the rear end cover.

If you like work, you can make a special spanner to engage the two holes in the end cover or, if lazy, simply stick in two bits of bar of the correct size and rely on finger strength. Tighten up until you cannot feel any shake in the arbor when you wiggle the tang end firmly back and forth in a radial direction. Spin it a few times and check for shake, tightening as necessary until you are quite sure there is none while the arbor rotates with a trace of drag from the grease. When you are sure you have it right, you can tighten the little brass 6 BA locking screw and insert a grub screw in the larger hole far enough for it to foul the screw projecting from the spacer. At this point, the non-running centre is returned to the spindle of the lathe for a series of light finishing cuts (Fig. 8), after which the grub screw can be backed out again. Run in for a few minutes at high speed. In use, a little grease does tend to make its way out through the clearance between the arbor and the end cover, but this is better than swarf and grit making its way in. If on checking there is still no shake, all that remains to be done is to see how much run out there is by using a dial test indicator.



SCRIBE A LINE

Readers' comments, views and reactions – in short, your opportunity to tell us and other MEW readers what you are making and how you do it. Let's be hearing from you!

Comments from a reader

Mr C. D. Harrington, C. Eng. F.I.E.E. of Maidstone, has written to us on several topics. First, a few words on issues one and two of M.E.W.

Issue one

The article on an electronic edge-finder was very thought-provoking. Firstly, I would suggest a more stable method of probe construction would be a co-axial arrangement of probe, insulator and chucking piece, which also enables the entire assembly to be machined at one setting, thus ensuring concentricity.

Rather than trouble to pin for contacts, crocodile clips fitted to the sensor unit (piezo-buzzer or meter) can simply be clipped on to the probe and workpiece fixings/table. This allows for easier storage and if the spindle should be started by accident the probe clip will simply detach itself, without a major wind up of the wires.

My interest in the article was that it stimulated thought to providing an early

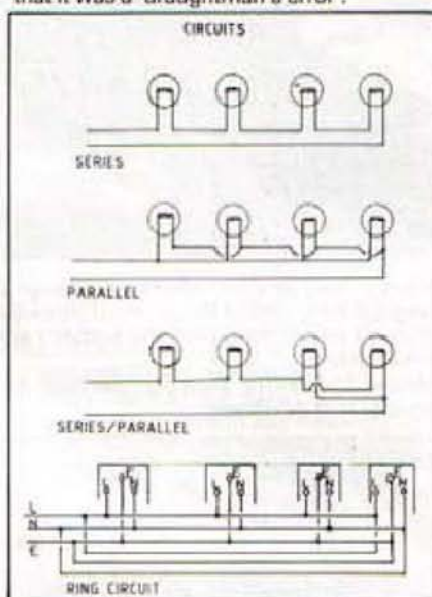
feel most strongly that any wiring articles presented to the unaware, must absolutely never create any possibility of doubt which might give rise to tragedy.

Similarly, I feel that you should have clarified that in the series connection of two lamps across a given supply, the power rating of each must be equal (ie resistance in this case) and rated at half voltage to obtain equal light output at full operation rating.

Issue two

The Simple Trepanning Tool, page 22. The use of a hexagon chucking shaft would prevent slippage when it is intended to use it with three-jaw chucking devices. I am always surprised that parallel circular shafts are specified for similar tools, such as fly cutters, boring heads, etc., where collet facilities are not available. Also grinding a flat along the cutter bit would more securely locate the cutter, if one does not wish to adopt square bits. However, it is a worthwhile project for a 'fit in' period

would not be possible to use equipment on them. It is possible that series circuits have a value in the case of lighting, particularly on Christmas trees. But the main object was to point out to readers that they were not of practical value, but perhaps could be when we come to electronics. The reasons for those particular drawings appearing is, to say the least, complicated, but as far as possible letters have been sent to all who wrote about it giving a full explanation. If some have been missed, please accept apologies. The best we can say in brief is that it was a 'draughtman's error'.



One other point that has also been raised on the subject is of three-phase electricity. The article was not meant to cover this in depth and the mention was purely to show the difference in that and single phase. Readers have rightly pointed out that there are three live wires as the neutral is also live. Once again, our thanks to all who wrote on the subject.

Formula for machining arcs

Allan Mackintosh of Camelford in Cornwall offers readers a useful formula for cutting segments of circles with accuracy, which we gladly pass on.

I particularly liked the article on high-temperature soldering and also the article on the small knurling tool; I would make-up one of the latter except that I have one of Marico's beautiful knurling tools, but on page 50, the swivel pieces, I have a large question mark – with the given dimensions, there is no way in which you can get 40mm radius.

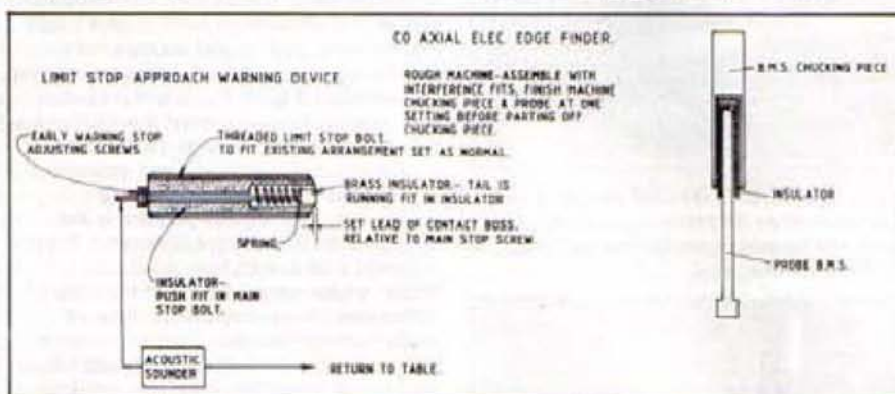
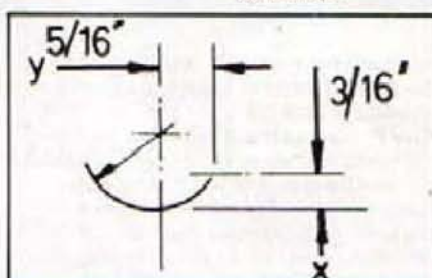
The situation is governed by a quadratic equation derived from Pythagoras:

$$X^2 - 2Rx + Y^2 = 0$$

$$\text{Solving for } R, R = \frac{-x^2 + y^2}{2x}$$

$$= \frac{-0.875^2 + 3.1275^2}{2 \times 3.75}$$

$$= 3.546 \text{ in. (or)}$$



warning indicator of approaching limit stops on the mill table or lathe. I dislike stop bumping, which often occurs when attention is focussed on workpiece/cutter and an audible warning, say five thou. before solid stops are reached, would be a good feature.

One worry I have with the non-rotating edge-finder is that it will suffer from variable errors, due to any chucking eccentricity. Whilst chucks should be accurate very few are. A rotating edge-finder would at least ensure that the substituted cutter would commence cutting at the located point. I have drawn sketches for the benefit of readers who may like to consider the idea.

Issue number 2

The article Electricity In The Workshop, pages 26/27. Having described series and parallel connections in the text it must be most confusing for the non-electrical minded reader to be presented with wiring diagrams denoted "in Series", "in Parallel", and "in Parallel Series", when in fact each drawing shows the outlets wired in parallel! Are the diagrams some adopted jargon of the electrical wiring industry terminology? Certainly, as an electronics engineer, I

which is now on the priority list.

Issue one

The Lathe Stops. The rear mounted carriage stop for the Myford 7 Series came at just the right moment. Slightly modified, mine is now "all present and correct". Having lost the sight of one eye in recent times due to a virus, I am no longer able to watch the chuck clearance to work and table at the same time. This can now be set, not only as a depth of cut stop, but also to prevent extended chuck jaws fouling the table.

These thoughts are sent constructively and with good wishes for a successful magazine.

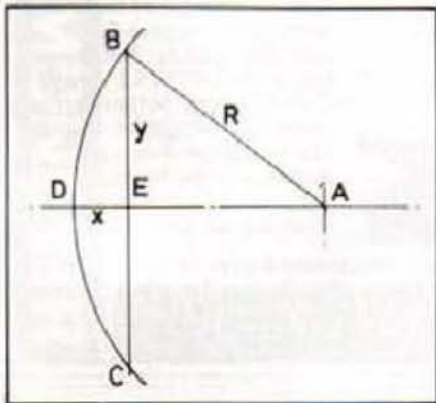
We are very grateful to Mr Harrington for his letter and the valuable ideas contained therein, which no doubt many readers will make use of. On his second point, Electricity in the Home Workshop, we have rightly received a large number of letters, not all quite as kindly worded as Mr Harrington's! If he thought readers would be confused to see the drawings as published then so was the editor. All showed parallel circuits. There is no question anyway of ever using series, or series parallel for power supplies as it

This is not nit-picking because the builder, having spent a half hour or more in scratching out the grooves in the arms with a half-round file and "blood, sweat and tears", will be distinctly put out when he finds that he can't make matching swivel pieces. The formula is derived from the following:

The name is from the Latin word "sagitta" meaning arrow; it will be seen that the figure resembles a bow and arrow.

Proofs for the following two theorems can be found in any textbook on elementary geometry; here, owing to lack of space, they are taken as working hypotheses without further proof.

- 1) A radius of a circle drawn to bisect a chord of that circle necessarily does so at right angles.
- 2) The square on the hypotenuse of a right triangle is equal to the sum of the squares on the other two sides. (Pythagoras' theorem)



triangle ABE is a right triangle (Theorem 1 above) and that the line AE is $AD - DE$ (or $R - x$).

Then, according to Theorem 2 above,
 $(R-x)^2 + y^2 = R^2$ and squaring out the first
term,
 $R^2 - 2Rx + x^2 + y^2 = R^2$
the R^2 terms cancel out and we are left with
the simple quadratic equation
 $x^2 - 2Rx + y^2 = 0$
Solving for x , we get $x = R \pm \sqrt{R^2 - y^2}$
for R , we get $R = \frac{x^2 + y^2}{x}$

for y , we get

Apologies for inflicting this simple maths on readers. The only excuse is that the quadratic is very useful in the shop and enables us to deal with segments of circles, cylinders and spheres, and also that apparently it is generally not well known.

Mr J.K. Widdowson of West Mersea writes asking readers for their assistance, and sends a valuable piece of advice for their benefit.

Can anyone help please? End Mills, etc., seem to become magnetised when used on my Senior type E vertical mill. A soak in a demagnetiser works on the cutters and chucks, but they become magnetised again when next used. Unused cutters are stored in a plastic box on the wall about 2 ft. from the milling machine, and rather less than that from the 3 Phase power supply, which is run in plastic conduit.

The air-cored area of my demagnetiser is about 2 in. square. To make one big enough to go over the mill spindle would be a major job.

A quid pro quo for the following quick tip: Tempering silver steel tools to "Pale Straw" depends on light conditions and it can be a bit tricky. British Standard Grade C Plumbers solder (60/40) has a melting point of 227°C, just between "Straw" at 230 and "Pale Yellow" at 221. Soaking the tool, after

hardening, in a small flask of Grade C solder, just molten, before quenching, removes guesswork.

A suitable flask is 3 in. of steel pipe, with the bottom blanked off, on a stand. Do not remove hardening scale or tarnish as this will prevent solder sticking to the tool. The solder may be obtained through a good plumber's merchant, though it may have to be ordered.

Mr J. A. Batchelor of Leeds has kindly sent the following in response to a request for assistance from Mr Simmons of Coventry. Our sincere thanks to Mr Batchelor. The tables included have been forwarded.

Re. Scribe A Line, Autumn M.E.W. Mr. Simmons of Coventry, and his watch screws.

I am not quite sure what he is after, but, enclosed are details of a few watch threads, see enclosed photostats. From these he could make his own taps and dies.

Another reference is the American Standard for Miniature Threads for watch and instruments (B1-10-1958) page 1285 Machinery Handbook. Eighteenth Edition. B.A. threads go down to No. 25 which has 363 threads per inch, full diameter 0.010", so plenty of scope there.

If he is just trying to identify the thread on old watch screws, then he would have to use optical methods, ie Toolmaker's Microscope, or my way, a Centering Microscope, with upper and lower lighting, used on the Milling Machine this would give pitch, thread angle, major and minor diameters.

If he just needs screws, then these can be purchased in assorted packs of 100 plus, if needed, taps and dies from H.S. Walsh and Sons Ltd. or, Southern Watch and Clock Supplies Ltd. both of London, or his local watch repair wholesaler.

My catalogues are old, but Tap and Die sets for these threads were expensive then in comparison to B.A. Whit. or B.S.F.

TRADE COUNTER

Tests have been carried out on a roller cutter marketed by Frost Auto Restoration Techniques Ltd, Crawford Street, Rochdale OL16 5NU. Consisting of a lightweight alloy casting with two hardened wheels, one serrated and the other chamfered, it proved to be a very good means of cutting thin sheet metal up to around 1mm in thickness.

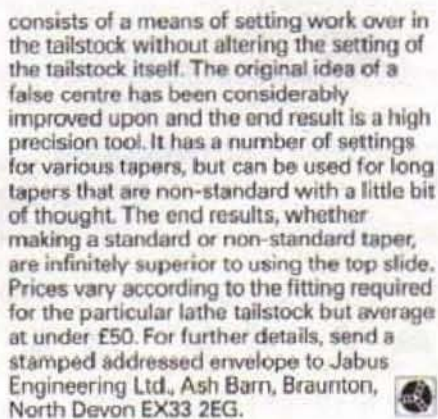


It has advantages over the more usual bench shear as it cuts to fairly tight radii and does not cause quite so much distortion of the metal. It is also useful in the home workshop where space is at a



premium, as it can be tucked easily into a drawer. An ordinary ring spanner is used as a handle and so even that does not get in the way. Marketed at £17.50 plus £2.50 postage it could make a useful addition to the workshop. A larger version for cutting up to 1.5mm sheet metal is also available priced at £85.56.

This little tool has been tried out in the making of a series of various tapers and has proved both easy to use and highly satisfactory. It is not a new idea and



The high precision Jabus taper turning tool

Looking for
a machine that is
precision built, durable,
accurate, versatile and
with a wide range of
accessories?



COWELLS 90 ME CENTRE LATHE
CENTRE HEIGHT OVER BED 400mm
SPIND OVER GAP 120mm
DISTANCE BETWEEN
CENTRES 200mm
CROSS SLIDE TRAVEL 100mm
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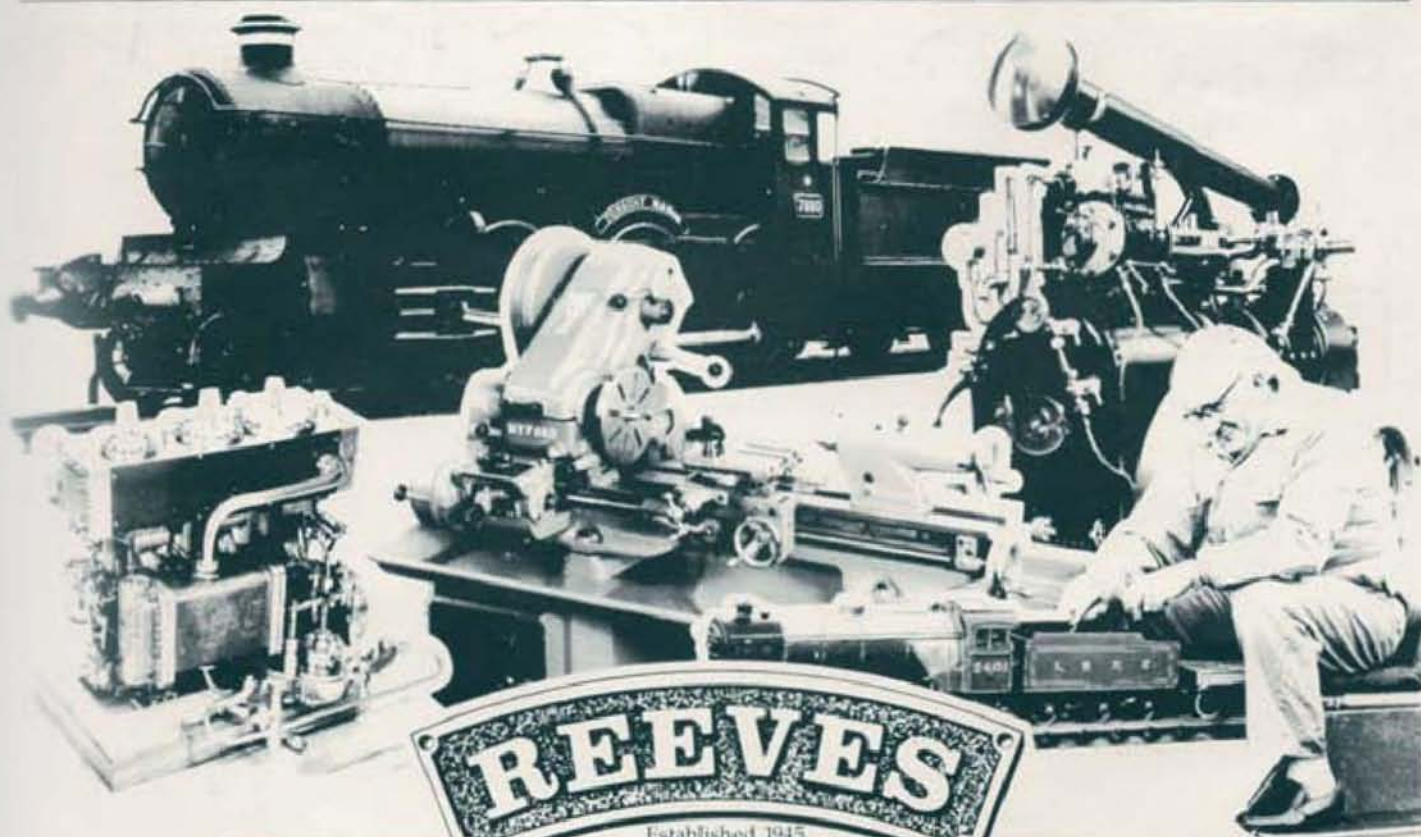
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